EPA Region 6 Announces Record of Decision Amendment Proposed Plan for Ground Water

South Cavalcade Street Superfund Site
Houston, Harris County, Texas July 2013

The Purpose of this Proposed Plan is to:

- Identify US Environmental Protection Agency's (EPA's) preferred remedial alternative to address the ground water contamination for the Shallow and Intermediate aquifer;
- Describe the remedial alternatives for ground water, considered in detail in the Focused Feasibility Study report and Focused Feasibility Study Addendum;
- Describe revisions to the Remedial Action Objectives (RAOs) for ground water;
- Solicit public review and comment on the proposed action, as well as information contained in the amended Administrative Record; and
- Provide information on how community members can be involved in the remedy selection and amendment process for the Site.

In this Proposed Plan (Plan), the U.S. Environmental Protection Agency (EPA) presents a re-evaluation of the ground water remedy selected in the 1988 Record of Decision (ROD), considers information derived through additional investigation and performance of the previously selected remedy, and identifies other remedial alternatives. The soil remedy selected originally in the 1988 ROD was soil washing and soil flushing. This remedy was amended subsequently in the 1997 ROD Amendment to excavation and consolidation of the contaminated soil and construction of a concrete cap to seal and contain the contaminated soil. The 1997 ROD Amendment addressed changes to the soil remedy only and did not address any changes to the ground water remedy that were selected in the 1988 ROD. This Plan addresses the changes to the ground water remedy only and does not address any changes to the soil remedy selected in the 1997 ROD Amendment. Hazardous substances remaining in ground water at the South Cavalcade Street Superfund Site, Houston, Texas, are addressed in this Plan. "South Cavalcade Site," or "Site," is used interchangeably with the more formal "South Cavalcade Street Superfund Site" in describing actions in this Plan.

The South Cavalcade Street Superfund Site is a former wood treating site located in Houston, Texas (see Figure 1), where ground water in two zones has been contaminated with dense non-aqueous phase liquids (DNAPL) and associated dissolved phase contaminants. The 1988 ROD required the extraction and treatment of contaminated ground water, including the recovery and treatment of DNAPL to the maximum extent practicable for both the Shallow and the Intermediate zone for both the Southern Area and Northern Area of the Site. The remaining contamination was to be allowed to naturally attenuate to background levels. From 1996 to 2006, ground water was extracted and treated which included the recovery and treatment of DNAPL. Since April 2006, DNAPL recovery has been via manual pumping from the collection wells.

Based on the long-term operation of the selected remedy for ground water in the 1988 ROD and a technical evaluation of its effectiveness, the EPA has concluded that it is technically impracticable to restore the dissolved contaminant plumes using pump and treat technology or other technologies because of the intermittent occurrence of residual and free-phase DNAPL in the aquifers. The ground water plumes in the two zones, Shallow and Intermediate, are not effectively responsive to existing treatment technologies. Natural attenuation of the ground water contaminants and

the lithologic characteristics of both zones act to limit expansion of the dissolved contaminant plumes.

The EPA Region 6, lead agency for the oversight of Site activities, with support from the Texas Commission on Environmental Quality (TCEQ), is issuing this Proposed Plan. The remedial actions implemented thus far at the Site are currently protective of human health and the environment. This Proposed Plan recommends the following preferred remedial alternative for the South Cavalcade Street Superfund Site for ground water and identifies steps to be taken for continual protection of human health and the environment.

- Contain the ground water contaminant plumes in the Northern Area and Southern Area, in both Shallow and Intermediate Zones, through natural processes, as restoration goals will not be achievable throughout the dissolved contaminant plumes.
- Waive the ground water cleanup levels for selected chemicals within a designated area, referred to as the Technical Impracticability (TI) Zone (see Figures 8); the boundaries of the TI Zone include both onsite and offsite areas and apply to both of the impacted aquifers in the Southern and Northern Areas of the Site.
- Prevent exposure to contaminated ground water above acceptable risk levels by implementing Institutional Controls (ICs) to restrict access to, or use of, contaminated water within TI Zone.
- Install additional monitoring wells and conduct short-term monitoring to verify the proposed TI Zone boundary; conduct long-term monitoring to ensure that the plume is not expanding and to evaluate areas of increasing or decreasing contaminant concentrations within the TI Zone; evaluate data periodically and take appropriate contingency measures as needed; remove DNAPL if present in the impacted monitoring wells.

The EPA, in consultation with the TCEQ, will select a final remedy for the Site after considering all information submitted during the 30-day public comment period.

The proposal and selection of a remedy for ground water as an amendment to the 1988 ROD is in accordance with the National Oil and Hazardous Substance Contingency Plan (NCP) §300.435(c)(2)(ii)(A) through (H). The actions proposed in this Plan are a continuation of those previous actions taken for the Site in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), 42 U.S.C. §9617(a) and 40 CFR Part 300. Issuance of the Plan will adhere to the public participation and documentation procedures specified in NCP §300.825(a)(2); and CERCLA §117(a).

Highlights of EPA's Preferred Remedial Alternative

Ground Water

- Contain the contaminant plume through natural processes.
- Waive the ground water cleanup levels for selected chemicals within the Technical Impracticability (TI) Zone.
- Prevent exposure to contaminated ground water above acceptable risk levels by implementing Institutional Controls (ICs) to restrict access to, or use of, contaminated water.
- Install additional monitoring wells and conduct short-term monitoring to verify the TI Zone boundary, conduct long-term monitoring to ensure that the plume is not expanding and to evaluate areas of increasing or decreasing contaminant concentrations within the TI Zone.

Community Participation

The Proposed Plan highlights key information from the *2012 Focused Feasibility Study Addendum*, 2011 *Final Focused Study Technology*, *2011 Technical Impracticability Demonstration Report*, 2006 *Supplemental Groundwater Characterization Report*, 2003 *Verification of Groundwater Fate and Transport Evaluation*, and 1997 *Groundwater Fate and Transport Evaluation Report* for the South Cavalcade Site. The EPA encourages the public to review these documents in order to gain a more comprehensive understanding of the South Cavalcade Site and the technical evaluation of alternative remedial options. The EPA also encourages the public to participate in the decision-making process for the South Cavalcade Site by providing comments on all aspects of the Administrative Record File including those documents which have been added to amend the record and support the decisions proposed in this Plan. The Administrative Record File is available at the following information repositories:

Houston Central Library
Houston Metropolitan Research Center
500 McKinney Street
Houston, Texas 77002
Monday, Tuesday, and Thursday: 10 am – 6 pm
Wednesday: 10 am – 8 pm
Saturday: 10 am – 5 pm
Friday and Sunday- Closed

Texas Commission on Environmental Quality
Building E, Records Management, First Floor
12100 Park 35 Circle
Austin, Texas 78753
(512) 239-2920
Monday – Friday – 8:00 am to 5:00 pm

A public meeting to receive comments will be held at the Jefferson Davis High School, 1101 Quitman St, Houston, Texas 77009, on August 6, 2013, from 6:00 PM to 8:00 PM. The public is invited to comment on this Proposed Plan to amend the ROD. Final decisions regarding the remediation of the South Cavalcade Site will only be made after public comments are considered. The official public comment period begins on July 25, 2013, and ends on August 23, 2013. During the public comment period, written comments may be submitted to:

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EPA, Region 6 (6SF-RA)
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The EPA, in consultation with the State of Texas, will select a final remedy for South Cavalcade Site after the public comment period has ended and information submitted during this time has been reviewed and considered. EPA will respond to all comments received during the public comment period in the Responsiveness Summary, which will be attached to the amended ROD. Both the Responsiveness Summary and the ROD Amendment will be available to the public at the two repository locations noted above. Note that the final site remedy may be different from the proposed remedy identified in this Proposed Plan based on comments, new information, or issues received during the public comment period. Such changes or alterations of this Proposed Plan will be explained and described in the ROD Amendment. The ROD Amendment will be signed by the Director of the Superfund Division for the EPA Region 6.

Site Background

Site History

The South Cavalcade Superfund Site occupies approximately 66 acres of land located approximately three miles north of downtown Houston, Texas, and about one mile southwest of the intersection of Interstate Loop 610 and U.S. Highway 59. The Site is bounded by Cavalcade Street to the north, Collingsworth Street to the south, and the Houston Belt & Terminal Railway Company (HB&T) Passenger Main to the east, and HB&T and Union Pacific Railroad to the west. The Site is situated in what would be considered a light industrial corridor, and is bounded on the west side by a large residential area. The Site is rectangular in shape and is approximately 3,400 feet long in the north-south direction by 900 feet long in the east-west direction.

A wood treating plant operated at the Site from 1910 until 1962. Creosote and various metallic salts were used as the wood preservatives. The wood treating process area was located in the southern portion of the Site along Collingsworth Street. Koppers Company, Inc. (Koppers), now known as Beazer East Inc. (Beazer), operated the wood treating facility from 1940 until its closure in 1962. A coal tar distillation plant was also operated by Koppers on the southeastern portion of the Site from about 1944 until 1962.

The Site is currently occupied by trucking firms, with much of the ground surface (particularly in the southern half of the Site) covered by pavement, buildings, or storage areas (see Figure 2). A ground water treatment facility is located at the eastern boundary in the central portion of the Site. From 1996 to 2006, ground water was extracted and treated which included the recovery and treatment of DNAPL. The ground water treatment system became inoperative due to a lightning strike in April 2006. Since April 2006, DNAPL recovery has been via manual pumping from the collection wells. Two areas of contaminated soil, along the southeastern boundary and in the south portion of the Site, have been capped and are being used for truck parking. The Northern Area of the Site is currently not occupied.

Site Contamination

Contaminants of concern for ground water included Polycyclic Aromatic Hydrocarbons (PAHs) including carcinogenic PAHs (cPAHs), benzene, toluene, ethylbenzene, xylene, and limited metals (arsenic, chromium, copper, lead, and zinc) with concentrations above background, associated with creosote-based operations.

History of Federal and State Investigations

The EPA proposed the South Cavalcade Site to the National Priorities List (NPL) on October 15, 1984 (49 Federal Register [FR] 40320), and added the Site to the final list on June 10, 1986 (51 FR 21054). EPA conducted a Remedial Investigation (RI) at the site from November 1985 to August 1988. Samples of the air, surface water, sediments, soil, and ground water were collected. Results confirmed contamination in the soil, sediments, and the upper ground water (shallow sand) unit at the site. The data for air and the drainage ditch water showed no measureable contamination. The ROD for the South Cavalcade Street Superfund Site was issued on September 26, 1988.

NPL Inclusion Proposal Date:	October 15, 1984
NPL Inclusion Final Date:	June 10, 1986
HRS Score:	38.69

The 1988 ROD addressed the ground water contamination and soil contamination. The selected remedy in the ROD for contaminated ground water was the extraction and treatment onsite using oil/water separation and carbon absorption. The 1988 ROD required the treatment of ground water to drinking water standards and no detectable cPAHs. Ground water extraction was to continue until ground water contaminants have been recovered to the maximum extent possible. At that point, collection was to cease and any remaining contamination was to be allowed to naturally attenuate to background levels. The 1988 ROD also made allowances to consider in-situ biological treatment to meet cleanup levels. Recovered DNAPLs were to be recycled as creosote or incinerated offsite.

The enhanced DNAPL recovery system was placed into service in early 1996. The recovery system operated until April 2006 when the system became inoperative as a result of a lightning related power surge that damaged the system controller. Since April 2006 DNAPL recovery has continued in passive mode (i.e., without ground water pumping) via manual pumping of DNAPL from the collection wells. As of December 2011 a total of approximately 4000 gallons of DNAPL have been recovered. The DNAPL recovery system was only able to remove an estimated 1.7% of the estimated total DNAPL mass.

Beazer submitted to the EPA and the TCEQ a draft Technical Impracticability (TI) Demonstration Report in March 2011. The report evaluates hydrogeologic factors, contaminant related factors, design and operations considerations, and exposure considerations and demonstrates the technical impracticability of additional removal of source material and of restoring ground water to meet the Applicable or Relevant and Appropriate Requirements (ARARs). This report recommends Monitored Natural Attenuation (MNA) with no Further Action for Source Zone as the remedy and recommends establishing a TI Waiver Zone for ground water ARARs.

Beazer also submitted to the EPA and the TCEQ a Technical Memorandum in March 2011 in which various lines of evidence are provided to demonstrate that natural attenuation is an effective ground water remedy for the ground water at the Site.

Beazer submitted to the EPA and the TCEQ the Final Focused Feasibility Study (FFS) in April 2011. In the report Beazer addresses four ground water remedial alternatives that include No Further Action, MNA with No Further Action for Source Zone, MNA with Continued Source Removal, and In-Situ Solidification. The report recommends MNA with No Further Action for Source Zone as the preferred alternative for the Site along with establishing a TI Zone to waive of ground water cleanup levels and establishing ICs to prohibit ground water use within the TI Zone.

Upon review and ongoing discussions with the EPA Headquarters (HQ) personnel and information gathered during a Site visit by the EPA HQ, the EPA Region 6, the TCEQ, and Beazer it was determined that based on continuous commercial operations and truck traffic at the southern portion of the Site, it is not practical to use active remedial treatment technologies at the southern portion of the Site. Since the Northern Area of the Site was unoccupied at the time of the Site visit, Beazer was requested to evaluate additional treatment alternatives for this portion of the Site. Beazer evaluated two alternatives, In-Situ Chemical Oxidation (ISCO) and In-Situ Solidification/Stabilization (ISSS), for the Northern Area of the Site. Beazer submitted a draft Focused Feasibility Study Addendum (FFSA) in April 2012 to the EPA and the TCEQ with the evaluation of these technologies for the Northern Area of the Site. Based on the evaluation against the nine cleanup criteria the 2012 draft FFSA recommends MNA with No Further Source Zone Action. Upon further discussion with the EPA HQ it was determined that MNA could not be used as a primary remedial alternative at the Site since calculations show that the time required to deplete the naphthalene at the Site is over 170 years.

Based on the long-term operation of the pump and treat system and a technical evaluation of its effectiveness, the EPA has concluded that it is technically impracticable to restore the dissolved contaminant plumes using pump and treat technology and other technologies because of the intermittent occurrence of residual and free-phase DNAPL in the aquifers. The ground water plumes in the two zones, Shallow and Intermediate, is not effectively responsive to existing treatment technologies. Natural attenuation of the ground water contaminants and the lithologic characteristics of both zones act to limit expansion of the dissolved contaminant plumes. Hence the remedial alternative of establishing TI Waiver Zones for the Southern and Northern Areas for both the Shallow and Intermediate Zones, with short-term and long-term monitoring, and waiver of the cleanup levels for the ground water plumes at the Site is being addressed in this Proposed Plan.

Site Characteristics

Physical Characteristics

The South Cavalcade Site is located in the quaternary Gulf Coast Plain of Texas. This region is underlain with Holocene and Pleistocene deposits. Ground water used to supply water for domestic, industrial, and agricultural purposes is pumped from the Lower Chicot and Evangeline aquifers. Both of these water bearing units are confined aquifers and are isolated from surface recharge. Public water supply wells are screened in the Evangeline aquifer at depths greater than 650 feet. Industrial water users in the general area have wells screened at depths greater than 275 feet.

Regionally, the topography slopes gently south toward the Gulf of Mexico. The Site is generally flat. It is drained by two stormwater drainage ditches which flank the "Site" on the east and west sides, and drain water into a storm sewer which discharges into Hunting Bayou, a tributary of the Houston Ship Channel. The Site is located above the 100-year and 500-year floodplain boundaries, as defined by the Federal Emergency Management Agency (FEMA).

The two water-bearing zones that are the focus of this Proposed Plan are not used as sources of drinking water onsite or downgradient of the Site. Onsite businesses and neighboring residents are served by the City of Houston water supply which originates from a deeper aquifer 10 miles from the site, or a surface water reservoir located over 20 miles from the Site. In addition, the Houston-Galveston Coastal Subsidence District requires notification and permits for the drilling of new ground water wells other than wells that only serve a single-family dwelling and have a casing diameter of five inches or less. The City of Houston continues to provide drinking water to onsite businesses and to neighboring residences and there are no domestic water wells in the immediate vicinity of the Site.

Although the Shallow and Intermediate zones are not currently being used as a source of drinking water, the potential exists that these water-bearing units could be utilized in the future. Current information shows that Shallow and Intermediate ground water is not currently being used in the vicinity of the Site and deeper ground water has not been impacted by Site-related constituents.

Soil Contamination

Soils in the Northeast area are not capped in place, but have been excavated and used, along with existing onsite stockpiled materials, as fill under the concrete cap structures in the Southeast and Southwest areas. The Northeast area has been backfilled with clean imported fill from an offsite source. The soil remedial action concrete cap system covers impacted as well as non-impacted areas in the Southeast and the Southwest areas, therein providing usable parking and driveway systems for the current property owners. The concrete cap is 8 inches thick in the Southwest area and 10 inches thick in the Southeast area. Although the contaminated soil was not treated prior to capping, the cap will provide a barrier preventing onsite workers from inadvertently ingesting, inhaling, or directly contacting contaminated soils.

Site Geology and Hydrogeology

The bottom of the Shallow Zone typically occurs at between 18 to 21 feet below ground surface. The Shallow Zone sand is thinner in the Southern Area of the Site than it is in the Northern Area, and pinches out completely in some offsite areas to the west and southwest. In the Northern Area, the Shallow Zone extends up to near the ground surface, although the upper portion is unsaturated. In the Southern Area, the Shallow Zone (where it is present) is typically overlain by a fine-grained layer dominated by clay. In general, the water-bearing zone in the Southern Area is poorly sorted and contains a greater percentage of fine-grained material relative to the water-bearing zone in the Northern Area. The ground water flow direction in the Shallow Zone in the Northern Area is west with an estimated average velocity of 126 ft/yr and in the Southern Area is southwest with an estimated average velocity of 28 ft/yr. The ground water flow direction in the Intermediate Zone in the Northern Area is west-northwest and in the Southern Area is southwest. The estimated average velocity for both Areas is 14.85 ft/yr.

The Shallow Zone sand is immediately underlain by a continuous fine-grained layer consisting of materials ranging from clay to sandy clay. This is the Intermediate Aquitard layer and is typically 30 feet thick and extends till approximately 40 to 50 feet below ground surface. The Intermediate Aquitard is a significant basal confining unit and serves as a hydraulic barrier for ground water flow between the Shallow and Intermediate Zones. The base of the Shallow Zone is interpreted as the contact between the Beaumont and Lissie Formations, with the latter extending beyond the depth of investigation.

The Intermediate Zone is situated between the Intermediate Aquitard and a lower aquitard. This Zone is highly variable in thickness and it is absent across most of the Northern Area of the Site and occurs below depths of 40-50 feet below ground surface. The maximum thickness of approximately 14 feet occurs in two disconnected lenses in the central area of the Site. Across much of the Southern Area, the Intermediate Zone is either absent or less than three feet thick. The aquitard underlying the Intermediate Zone is laterally continuous across the Site. It has a minimum thickness of approximately 40 feet and typically extends to approximately 115 feet below grade.

Ground Water Contamination

Field investigations were conducted by Beazer in October 2012 in the Northern Area and in June 2013 in both Northern and Southern Areas, to verify the extent of ground water contamination (see Figures 3-7). Ground water contamination at the South Cavalcade Site is present in the dissolved phase and free-phase in both the Shallow sand aquifer and the Intermediate aquifer. The primary Contaminants of Concern (COCs) for ground water are Polycyclic Aromatic Hydrocarbons (PAHs) including carcinogenic PAHs (cPAHs), benzene, toluene, ethylbenzene, xylene, and limited metals (arsenic, chromium, copper, lead, and zinc) with concentrations above background, associated with creosote-based operations. The cPAHs are benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. Ground water sampling conducted by Beazer in 2013 provides the most recent and comprehensive snapshot on the extent of contamination in both the Shallow and Intermediate Zones. Results are included in the Administrative Record.

The October 2012 investigation in the Northern Area showed an intermittent and sporadic presence of DNAPL in the soil and was present in the form of as oil spots, sheen, and/or saturated area (see Figures 4 and 5). The lateral extent of the dissolved contaminant plumes has been delineated in all directions in the Shallow Zone and Intermediate Zone. The dissolved contaminant plumes in these Zones extend from these source areas towards the west. The majority of the dissolved plume is located within the boundary of the site. In the Intermediate Zone in the Northern Area contamination has not migrated offsite at concentrations greater than the MCL of 5 µg/L for benzene and Texas residential drinking water standard of 490 µg/L for naphthalene. In the Intermediate Zone in the Southern Area the benzene and naphthalene contaminations above these drinking water standards have migrated west to the Harris Country Toll Road Authority (HCTRA) right-of-way. The dissolved contaminant plume in the Shallow Zone is more extensive than in the Intermediate Zone for the Southern and Northern Areas. In the Shallow Zone, benzene and naphthalene contaminations above the drinking water standards have migrated off the western boundary of the site and the downgradient extent is located between Elysian Street and Maury Street.

Ground Water Modeling Summary

Beazer undertook a series of fate and transport modeling efforts and site investigations, beginning with the August 1997 “Groundwater Fate and Transport Evaluation” (GFTER). Beazer submitted the modeling and investigation results to the EPA for review and approval. The fate and transport modeling presented in the GFTER was completed by Beazer as a preliminary evaluation of whether natural attenuation processes were sufficient to meet the remedial objectives for shallow ground water at the Site. The results of the GFTER supported a preliminary hypothesis that effective natural attenuation of dissolved organic constituents of interest (COI) is occurring in the Shallow Zone at the Site.

In July 2000, Beazer submitted to the EPA a study pursuant to the Work Plan for Verification of the Groundwater Fate and Transport Evaluation (VGFTER). The VGFTER presented the results of a rigorous site investigation to further evaluate the MNA conclusions of the GFTER. The results of the VGFTER supported the conclusion of the GFTER modeling that a MNA remedy is feasible for dissolved phase COIs in shallow ground water at the South Cavalcade

Site. The EPA concluded its review of the VGFTER in July 2003. Subsequent to the submittal/review of the VGFTER, Beazer and the EPA completed thorough evaluations of historic Site data and information to ensure that all Site source areas and potential preferential pathways had been identified and investigated

In addition to the ongoing DNAPL recovery operation, Beazer has conducted annual ground water monitoring in one deeper monitoring well located in the vicinity of the Site. The well monitors the "200-Foot Sand" aquifer at a depth of approximately 220 feet below ground surface. The results of this monitoring show that this ground water-bearing unit has not been impacted by Site-related constituents**.** Although, another well that monitors a deeper sand unit at approximately 500-feet below ground surface has not been sampled due to an obstruction in the well, no impact from the Site is expected in this well since no contaminants were discovered in the shallower 220 foot well.

Field work associated with the Supplemental Groundwater Investigation was conducted in September 2005 to investigate potential preferential pathways, delineate shallow ground water impacts downgradient (southwest) of the Site and provide additional data for design of MNA program. The Supplemental Groundwater Investigation Report was submitted to the EPA and the TCEQ in March 2006. Benzene concentrations were less than the ROD remedial goal and naphthalene concentrations were less than a tap-water based screening criterion in all the temporary well ground water samples and the samples collected in the area to the southwest of the Site. These results conclusively show that significant constituent migration is not occurring within the targeted potential migration pathways in the Shallow Zone and the Intermediate Zone. The results confirm that the dissolved phase COI distributions are limited to within a relatively short distance of the source areas. The results of this Supplemental Groundwater Characterization support the earlier recommendation in the VGFTER of the incorporation of a MNA component into the ground water remedy for the Site.

Summary of Site Risks

The original 1988 ROD directed that response actions be taken at the Site to protect public health and the environment from the release or threatened release of hazardous substances from the Site. The ROD specified that there was no current exposure to local residents or onsite workers. Potential future exposure pathways were evaluated for possible impacts to human health. The risk assessment concluded that adverse effects to human health and the environment could result if no action was taken to prevent exposure to contaminants found at the site. The principal exposure pathways leading to unacceptable risks were those involving surficial soils and ground water.

Beazer submitted a Human Health Risk Assessment (HHRA) Technical Memorandum in April 2011. This re-evaluated the exposure scenarios and potential risks to human health since the original risk assessment. This included exposure to both the Shallow Zone and Intermediate Zone ground water contamination and included an assessment for both onsite and offsite risk, and considered a vapor intrusion pathway. The HHRA assessed current and future health risks from concentrations in ground water to people that may work and/or live on and/or near the Site. Data collected from onsite and offsite during 1999, 2000, and 2005 sampling events were used in the HHRA. Benzene, Toluene, Ethyl Benzene, and Xylene (BTEX) and Poly Aromatic Hydrocarbons (PAHs) were detected in onsite and offsite ground water. An additional population group, the future onsite commercial/industrial worker, was evaluated for human health risk in June 2013.

Risk levels below the acceptable risk value indicate the protectiveness of human health and the environment and risk levels above the acceptable risk value indicate the need for action to prevent exposures. Potential excess lifetime cancer and potential non-cancer risks for the current/future onsite worker and future offsite highway construction worker were below acceptable risk value. Potential excess lifetime cancer risk for current/future onsite utility worker and future onsite construction worker were below acceptable risk value, however, the non-cancer risk for this population group was above the acceptable risk value. Potential excess lifetime cancer risk and potential non-cancer risks for future offsite residents and future onsite industrial/commercial worker were above the acceptable risk values. Since there are scenarios in which the risk levels are above acceptable risk values that indicate the need for action to prevent exposures, ICs prohibiting future ground water use need to be established within the TI Zones to eliminate potential future exposure.

Contaminants of Concern (COCs)

The following constituents are considered to be Contaminants of Concern (COCs) for ground water at the Site and are the same as in the 1988 ROD

- PAHs including carcinogenic PAHs (cPAHs), Benzene, Ethylbenzene, Toluene, Xylene, Arsenic, Chromium, Copper, Lead, and Zinc.
- *Carcinogenic PAHs are Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Chrysene, Dibenzo(a,h)anthracene, and Indeno(1,2,3-cd)pyrene.*

Land and Groundwater Use Assumptions

Land Use

Land use in the vicinity of the Site is a mixture of commercial, industrial, and residential properties. Industrial and commercial properties are located to the east and across Collingsworth Street to the south. Active rail lines immediately border the Site boundaries to the east and the west. The North Cavalcade Street Superfund Site is located directly north of the South Cavalcade Site, separated by Cavalcade Street. A residential area is located to the west of the Site, and continues to the south, north, and west. In the residential block immediately west of the Northern Area, most of the houses have been removed, and the area is now vacant.

Use of the property at the Site is expected to remain commercial into the foreseeable future. The HCTRA will be constructing an extension of the Hardy Toll Road in the near future, along the existing rail right-of-way at the western boundary of the Site. The Hardy Toll Road construction will further separate the Site from the residential area to the west.

Ground Water Use

As mentioned in the Summary of Site Characteristics, the Shallow Zone and Intermediate Zone aquifer are not being used for sources of drinking water onsite or within the vicinity of the Site. Although a deep onsite aquifer is potentially useable as a future public water supply source, onsite workers and neighboring residents are served by the City of Houston water supply which originates from a deeper aquifer 10 miles from the Site, or a surface water reservoir located over 20 miles from the Site. Although the shallow water-bearing zones are not currently being used as a source of drinking water, the potential exists that ground water from these zones could be utilized in the future. Based on sustainable yields from the Shallow Zone and Intermediate Zone and limited water quality data, although both water bearing units could theoretically be used as a future drinking water source, it is highly unlikely. Site property owners are prohibited from installing ground water production wells on their properties by virtue of their respective Administrative Order on Consent (AOCs) with the United States and corresponding settlement/access agreements with Beazer. Water from the public supply is readily available in the area surrounding the Site and is more cost effective than utilizing ground water as a source of water. The shallow aquifer cannot sustain an extraction rate of more than 2 gallons per minute thus precluding commercial or industrial shallow ground water use which typically has much greater production demands.

Potential Exposure Pathways

Ground Water – Public water supply wells are screened in the Evangeline Aquifer at depths greater than 650 feet. All local residents are connected to the City of Houston public water supply. Therefore, under current Site use conditions, there is no plausible potential for local residents to be exposed to ground water contaminated by the Site. However, both water bearing units could theoretically be used as a future drinking water source, therefore, future use of the ground water at the Site must be considered in the evaluation of remedial options.

Soil – The soil remedial action concrete cap system covers impacted as well as non-impacted areas in the Southeast and the Southwest areas. The concrete cap is 8 inches thick in the Southwest area and 10 inches thick in the Southeast area. Soils in the Northeast area are not capped in place, but have been excavated and used, along with existing onsite stockpiled materials, as fill under the concrete cap structures in the Southeast and Southwest areas. The Northeast area has been backfilled with clean imported fill from an offsite source. The implemented remedy

will continue to be protective as long as the cap is maintained. The capped area is being used for parking and as a driveway by the current property owners. The 1997 ROD Amendment states that as long as the cap remains in place there will be no exposure pathway.

Vapor Intrusion – The potential for the occurrence of adverse health effects associated with vapor intrusion into indoor air was evaluated using Johnson and Ettinger Vapor Intrusion Model under current and anticipated future land use. Occupied buildings currently exist at the Site. These buildings are of slab on grade construction and are directly underlain by fill and clay. With the exception of the Tire Shop Building on the Palletized Trucking property, the buildings are not located over source areas which were delineated via historical site investigations. The evaluation was completed based on review of Site analytical data, Site physical conditions, the Conceptual Site Model, and activity information. The results indicated that the highest concentrations found in the ground water under the Tire Shop Building do not exceed acceptable risk levels. The results of this evaluation indicate that vapor intrusion is unlikely to be a potential exposure pathway at the Site.

Exposure Pathways Affecting Each Population Group

Current and future land use-based exposure pathways through the use of ground water were evaluated in the April 2011 HHRA and June 2013 HHRA Addendum for the Site. The following receptors were evaluated for onsite and offsite areas of the Site in the HHRA:

Current/Future Onsite Worker – onsite potential exposure via inhalation of vapors in indoor air in the tire shop (due to vapor intrusion).

Current/Future Onsite Utility Worker – onsite potential exposure in utility trenches via incidental ingestion, dermal contact, and inhalation of vapors in air (due to vapor intrusion) in a trench.

Future Onsite Construction Worker – onsite potential exposure in excavated areas via incidental ingestion, dermal contact, and inhalation of vapors in air (due to vapor intrusion) within the excavated area.

Hypothetical Future Offsite Highway Construction Worker – offsite potential exposure in excavated areas via incidental ingestion, dermal contact, and inhalation of vapors in air (due to vapor intrusion) within the excavated area.

Hypothetical Future Offsite Adult/Child Resident – offsite potential exposure due to domestic ground water use via ingestion (drinking water), dermal contact, and inhalation of vapors (during a shower).

Future Onsite Industrial/Commercial Worker - onsite potential exposure due to ground water use via ingestion (drinking water), dermal contact, and inhalation of vapors (during a shower).

Since drinking water is provided by the City of Houston and shallow water is typically not used for drinking purposes, evaluation of potential risks associated with domestic use or drinking use of ground water represents a very conservative exposure scenario. The HCTRA has plans to extend the Hardy Toll Road from Loop 610, along the Site's western boundary, into downtown Houston. Therefore, future onsite and offsite construction activities assumed in this assessment could occur in the near future. Direct contact with ground water is not anticipated with the Toll Road construction. The evaluation of the risk of a construction worker who has direct contact with the ground water is a very conservative approach and represents the higher end of likely exposure at the Site.

Summary of Human Health Risk Characterization for Potential Exposure to Ground Water

Risk estimates were calculated for future land use scenarios for hypothetical human receptors at the Site. Cancer risks were estimated as the probability of an individual developing cancer over a lifetime as a result of exposure to the Site's carcinogenic contaminants. The potential for non-carcinogenic hazards due to potential exposures to

chemicals was evaluated by calculating an Hazard Index (HI) for the COCs at South Cavalcade Site. The HHRA shows the detailed calculation of risk and organized the types of risk at the Site according to various exposure scenarios. Each exposure scenario specifies the type of human receptor (e.g., child resident, adult industrial worker), the exposure pathway (e.g., inhalation, ingestion) and the COC. If a contaminant or exposure scenario is found to produce a risk which will require a remedial action (based on either the carcinogenic risk or the HI) that contaminant or exposure scenario is said to "drive the risk" or "drive" the need for action. A remediation goal is set for the Site-related COCs that drive risk. The following exposure scenarios are driving the need for action at the Site (all risks are expressed as Reasonable Maximum Exposure or RME). Risk levels below the acceptable cancer risk value of $1x10^{-4}$ and non-cancer HI of 1 indicate the protectiveness of human health and the environment. For risk levels above these acceptable values, action is to be implemented to prevent the exposure.

Current/Future Onsite Worker – The potential cancer risk is $1x10^{-14}$ and potential non-cancer risk 0.4. These are below the acceptable values and indicate protectiveness of human health and the environment.

Current/Future Onsite Utility Worker – The potential cancer risk is $4x10^{-6}$ which is below the acceptable risk value. The potential non-cancer risk is 4 which is above the acceptable risk value and action is to be taken to prevent exposure.

Future Onsite Construction Worker – The potential cancer risk is $2x10^{-5}$ which is below the acceptable risk value. The potential non-cancer risk is 2 which is above the acceptable risk value and action is to be taken to prevent exposure.

Hypothetical Future Offsite Highway Construction Worker – The potential cancer risk is $8x10^{-5}$ and the potential non-cancer risk is 0.9. These are below the acceptable values and indicate protectiveness of human health and the environment.

Hypothetical Future Offsite Adult/Child Resident – The potential cancer risk is $5x10^{-3}$ and the potential non-cancer risk is 90. These are above the acceptable risk values and action is to be taken to prevent exposure.

Future Onsite Industrial/Commercial Worker - The potential cancer risk is $1x10^{-2}$ and the potential non-cancer risk is 300. These are above the acceptable risk values and action is to be taken to prevent exposure.

Based on the results of the HHRA, current onsite and offsite ground water conditions exceed the acceptable risk value for the above evaluated potential exposure scenarios and action is to be implemented to prevent the exposure.

Remedial Action Objectives and Goals

Remedial Action Objectives (RAOs) provide a general description of what a Superfund cleanup is designed to accomplish. This section provides a discussion of the existing Remedial Action Objectives (RAOs) and Preliminary Remedial Goals (PRGs) as defined in the 1988 ROD for the South Cavalcade Site, as well as a discussion of the development of revised RAOs for this Proposed Plan.

RAOs are developed to consider the COCs, exposure route(s), receptor(s), applicable federal and state standards, and anticipated future land use for the Site. The RAOs developed in the 1988 Feasibility Study for soil and ground water at the Site required that existing contamination be removed and/or treated to ensure that human health and the environment are protected. The original RAOs from 1988 and the revised ones proposed in this plan are given below.

Ground Water RAO (1988)

- Prevent the vertical migration of contaminants to low ground water zones or horizontal migration to offsite wells

Ground Water RAO (2013)

- Contain two ground water containment plumes, associated with the Shallow Zone and the Intermediate Zone (*containment*);
- Prevent human exposure to contaminated ground water above acceptable risk levels (*prevent exposure to contaminated ground water above acceptable risk levels*);
- Remove source *(source removal)*

The ground water RAOs meet the expectations for contaminated ground water under the National Contingency Plan (NCP) considering the Site-specific conditions. The revised RAOs are applicable to both the Shallow Zone and Intermediate Zone; the two DNAPL source areas (Northern and Southern) that impact the Shallow Zone, the Intermediate Zone, and the dissolved phase contaminants associated with both source areas.

PRGs provide numerical criteria that can be used to measure progress in meeting the remedial action objectives for the cleanup. The original PRGs for ground water at the Site were established in the 1988 ROD, as follows:

Ground Water PRGs (1988 ROD)

cPAHs – non-detect ((at normal laboratory procedures – use 0.1 µg/L)
Benzene – 5 µg/L
Ethylbenzene – 142 µg/L
Toluene – 28 µg/L
Xylene – 440 µg/L
Arsenic – 50 µg/L
Chromium – 50 µg/L
Copper – 28 µg/L
Lead – 50 µg/L
Zinc – 100 µg/L

The 1988 PRGs were selected to comply with Federal drinking water standards, NPDES Best Available Technology Economically Achievable (BAT) requirements, and Texas Water Quality standards which are relevant and appropriate requirements or reflect existing background ground water concentration levels. The remedial level for cPAHs was selected to assure that, in conjunction with other contaminants, the overall risk to potential consumers of ground water will be less than 10^{-4}. The actual risk will be lower as natural adsorption reduces the concentration of PAHs and metals. Levels were developed for copper and zinc based on the principle of keeping the HI less than 1.

The Shallow Zone and Intermediate Zone were assessed as having potential future use as drinking water sources. In this Plan, the preferred remedial alternative selects the waiver of ARAR-based cleanup levels within the designated TI Zone. The ARARs are the federal drinking water standards which are the Maximum Contamination Limits (MCLs) and secondary standards. In the absence of the federal drinking water standards, the ARARs are the State residential drinking water standards which are the Protective Concentration Levels (PCLs).

Contaminant	ARAR (µg/L)	Source
Acenapthylene	1500	TCEQ PCL
Acenaphthene	1500	TCEQ PCL
Anthracene	7300	TCEQ PCL
Benzo(a)anthracene (cPAH)	1.3	TCEQ PCL
Benzo(a)pyrene (cPAH)	0.2	EPA MCL
Benzo(b)fluoranthene (cPAH)	1.3	TCEQ PCL
Benzo(k)fluoranthene	13	TCEQ PCL

Contaminant	ARAR (µg/L)	Source
Benzo(g,h,i)perylene	730	TCEQ PCL
Chrysene (cPAH)	1300	TCEQ PCL
Dibenzo(a,h)anthracene (cPAH)	0.2	TCEQ PCL
Fluoroanthene	980	TCEQ PCL
Fluorene	980	TCEQ PCL
Indeno(1,2,3-cd)pyrene (cPAH)	1.3	TCEQ PCL
2-Methylnaphthalene	98	TCEQ PCL
Naphthalene	490	TCEQ PCL
Phenanthrene	730	TCEQ PCL
Pyrene	730	TCEQ PCL
Benzene	5	EPA MCL
Ethylbenzene	700	EPA MCL
Toluene	1000	EPA MCL
Xylene	10000	EPA MCL
Arsenic	10	EPA MCL
Chromium	100	EPA MCL
Copper	1300	EPA MCL
Lead	15	EPA MCL
Zinc	5000	EPA Secondary Standards

Pentachlorophenol (PCP) was found above the MCL of 1 µg/L in one onsite shallow well in the Northern Area during the June 2013 sampling event. Historical Site information indicates that PCP was not used as part of the wood treating process at the Site. Since PCP was found in only one interior shallow monitoring well and not in any Intermediate, downgradient, or offsite wells, future ground water monitoring results will be evaluated to determine the extent of this contaminant. In addition, two shallow offsite temporary wells installed in the Southern Area at the proposed TI Zone boundary show PCP concentrations of 1 and 1.1 µg/L. These temporary wells were installed in an area where utility poles are present and are downgradient of railroad lines. Since PCP was not found in any onsite Shallow or Intermediate Zone wells, the source of the PCP in these wells are unknown. Future ground water monitoring results will be evaluated to determine if these PCP levels are from the Site.

Summary of Remedial Alternatives

Remedial alternatives have been developed based on media impacted. These alternatives are analyzed in more detail in the 2011 Final FFS and 2012 draft FFSA, which is part of the Amended Administrative Record File.

Ground Water Alternatives

- **Alternative G-1:** *No Action*
- **Alternative G-2:** *MNA with No Further Action for Source Zone*
- **Alternative G-3:** *MNA with Continued Source Removal*
- **Alternative G-4:** *In-Situ Solidification/Stabilization (ISSS) of Source Materials*
- **Alternative G-5***:Technical Impracticability (TI) Waiver with No Further Action for Source Zone*
- **Alternative G–6:** *In-Situ Chemical Oxidation (ISCO) for Northern Area*
- **Alternative G-7:** *In-Situ Solidification/Stabilization (ISSS) for Northern Area*

Common Remedial Alternative Components

Each of the ground water remedial alternatives, excluding the No Action Alternative G-1, has the following common components:

- TI Waiver – It is highly likely that dissolved phase COCs will be present in the ground water even with source treatment. The dissolved phase COCs will take a length of time to naturally attenuate to meet ground water RAOs. Depending on how long attenuation takes a TI Waiver Zone may need to be established for each of the alternatives that have a treatment component of the source material.

- Ground Water Monitoring Program – A ground water monitoring program provides an on-going comparison to historical ground water conditions and the necessary data to evaluate the performance of the selected remedy to meet the RAOs for the Site. The monitoring program monitors conditions both onsite and offsite, and documents changes through on-going processes, such as natural attenuation.

- Institutional Controls (ICs) – ICs are non-engineered instruments such as administrative and/or legal controls that minimize the potential for human exposure to contamination by limiting land use or resource activities. ICs are to be implemented to prevent exposure to contaminated ground water above acceptable risk levels by restricting access to, or use of, contaminated water. ICs (i.e. deed restrictions, or restrictive covenants) will be put in place to provide notice to property owners and prospective purchasers that contaminated water from the Shallow and Intermediate Zones should not be used for drinking water or non-drinking uses. The AOC between the EPA and the property owners that is already in place needs to be amended to include the current property owners.

- Annual Inspection/Review – Annual inspections will be conducted to evaluate the integrity of condition of the containment caps and identify necessary actions to be taken. In addition annual evaluations of the Houston-Galveston Coastal Subsidence District (HGCSD) well registration records will be reviewed to ensure that land and ground water use at and in the vicinity of the Site has not changed and to verify the continued absence of complete exposure pathways for the Site ground water.

- Five-Year Review –Reviews are required every five years whenever a remedial action results in hazardous substances, pollutants, or contaminants remaining onsite above levels that do not allow for unlimited use and unrestricted exposure. In each of the ground water remedial alternatives, contaminants will remain in the ground water at concentrations above the Site ARARs. Five-year reviews were previously conducted for the Site in 2002, 2007, and 2012, and will continue on a five-year cycle.

- Technical Support – This component includes the continual technical evaluation of the selected remedy, including, but not limited to monitoring network and field and analytical data. This support will provide real-time evaluation of the selected remedy with the purpose of optimizing the operation and effectiveness of the selected remedy and monitoring program.

Alternative G-1 – No Action

Estimated Capital Cost: $0
Estimated Present Worth Operations and Maintenance (O&M) Cost: $0
Estimated Total Present Worth Cost: $0

Alternative G-1 assumes no remedial action for contaminated ground water beyond that already performed. Under this alternative no action would be conducted at the Site to prevent COC migration, and no provisions would be included for ICs to restrict ground water use. Although this alternative does not meet the ground water RAO, it is considered in this evaluation as a baseline for comparison to other remedial alternatives as required by the NCP.

Alternative G-2 –MNA with no further action for the Source Zone (for Southern and Northern Areas)

Estimated Capital Cost: $167,188
Estimated Present Worth O&M Cost: $1,010,154
Estimated Total Present Worth Cost: $1,177,341

This alternative would consist of the development and implementation of a MNA program. The primary objectives of the MNA program would be to provide ongoing confirmation that natural attenuation is effective in controlling migration of Site constituents and also to provide for the early detection of any upward trends indicative of potential COC migration. To accomplish these objectives, it would be necessary to replace some of the lost and/or damaged monitoring wells that were sampled in the past and install additional downgradient monitoring wells. The installation of these monitoring wells would allow for the collection of additional ground water data to better detect any future changes in Site ground water conditions.

As previously discussed, because it has been determined that significant DNAPL recovery is technically impracticable, and because natural processes appear to adequately control dissolved phase COC migration, the operation of the existing ground water pumping/DNAPL recovery system would be discontinued under this alternative. All piping and the treatment plant would be permanently removed from service and would be decommissioned and dismantled.

Implementation of this alternative would require a TI Waiver of ground water cleanup levels, specified in this Proposed Plan, within the TI Zone. The TI Zones consist of the delineated source areas and the downgradient areas where dissolved constituent concentrations exceed ground water cleanup levels and ARARs. The 2011 draft TI Demonstration Report presents the justification for a TI Waiver to select a MNA remedy, and thus the necessity to amend the ROD. In addition, this MNA alternative would require that ICs be established to prohibit ground water use within the TI Zones in perpetuity. ICs, such as deed restrictions and restrictive covenants need to be established. The AOC between the EPA and the property owners that is already in place needs to be amended to include the current property owners. On-going long-term monitoring will be required to monitor the Shallow Zone and the Intermediate Zone. This alternative would include annual evaluations of the Site and the HGCSD well registration records to ensure that land and ground water use at and in the vicinity of the Site does not change and to verify the continued absence of complete exposure pathways for Site ground water. This alternative will also include Five-Year Reviews.

The primary components of Alternative G-2 include:

- Decommissioning and Dismantling of Existing Ground Water Treatment System
- TI Waiver
- Installation of New Ground Water Monitoring Wells
- Long-Term Ground Water Monitoring
- Institutional Controls
- Annual Inspection/Review
- Five-Year Review

Alternative G-3 – MNA with continued Source Removal (for Southern and Northern Areas)

Estimated Capital Cost: $154,938
Estimated Present Worth O&M Cost: $5,237,578
Estimated Total Present Worth Cost: $5,392,515

Alternative 3 also consists of the development and implementation of a MNA program comparable to that discussed under Alternative 2. In addition, the existing DNAPL collection and ground water treatment plant systems would continue to operate in the gradient enhanced mode.

Because the existing ground water treatment system is currently inoperative, the system would require significant repairs. As a primary component of Alternative 3, an evaluation would be performed to determine if a smaller, more cost-effective system is appropriate.

This alternative would require the use of a TI Waiver and ICs similar to Alternative 2. ICs, such as deed restrictions and restrictive covenants need to be established. The AOC between the EPA and the property owners that is already in place needs to be amended to include the current property owners. On-going long-term monitoring will be required to monitor the Shallow Zone and the Intermediate Zone. This alternative would include annual evaluations of the Site and the HGCSD well registration records to ensure that land and ground water use at and in the vicinity of the Site does not change and to verify the continued absence of complete exposure pathways for Site ground water. This alternative will also include Five-Year Reviews.

The primary components of Alternative G-3 include:

- Repair or Replacement of Existing Ground Water Treatment System (source removal)
- TI Waiver
- Installation of New Ground Water Monitoring Wells
- Long-Term Ground Water Monitoring
- Institutional Controls
- Annual Inspection/Review
- Five-Year Review

Alternative G-4 – In-Situ Source Stabilization ISSS of Source Materials (for Southern and Northern Areas)

Estimated Capital Cost: $16,558,025
Estimated Present Worth O&M Cost: $1,579,598
Estimated Total Present Worth Cost: $18,137,623

Under this alternative, soils containing source materials (i.e., DNAPL) would be treated via In-Situ Solidification/Stabilization (ISSS) Implementation of the ISSS remedy would limit the leaching of COCs from source materials into ground water and would reduce the permeability of the soil matrix to limit contact between ground water and impacted soils. In the Southern Area, much of the area is developed and this remedy was evaluated for source areas that are currently accessible and that are not under surface improvements, including roads, railroads, and utilities.

The ISSS process involves the mechanical mixing of reagents into the soils using equipment such as a backhoe, excavator, rotary mixer, or large diameter auger. The primary ISSS reagent(s) and application rate would be determined during a bench scale treatability study, which would be conducted during the remedial design. Based upon the estimated source extent in the Shallow Zone, approximately 155,000 cubic yards of soil would require treatment. Once completed, the Site would be regraded and sloped to promote positive drainage.

The operation of the existing ground water pumping/DNAPL recovery system would be discontinued under this alternative. All piping and the treatment plant would be permanently removed from service and would be decommissioned and dismantled. ISSS will treat the soils containing the source materials but will not address the dissolved contaminant plumes. Hence, implementation of this alternative would require a TI Waiver of ground water cleanup levels, specified in this Proposed Plan, within the TI Zone. This alternative would require the use of ICs to ensure restrictions are place to prevent digging, excavation etc. To substantiate the ICs' prohibition on ground water use, verification that ground water is not being used will be made in conjunction with the long-term ground water monitoring program. ICs, such as deed restrictions and restrictive covenants need to be established. The AOC between the EPA and the property owners that is already in place needs to be amended to include the current property owners.

On-going long-term monitoring will be required to monitor the Shallow Zone and the Intermediate Zone. This alternative would include annual evaluations of the Site and the HGCSD well registration records to ensure that land and ground water use at and in the vicinity of the Site does not change and to verify the continued absence of complete exposure pathways for Site ground water. This alternative will also include Five-Year Reviews.

The primary components of Alternative G-4 include:

- Decommissioning and Dismantling of Existing Ground Water Treatment System
- In-Situ Source Stabilization (shallow soil mixing)
- Management of swell materials generated during stabilization
- Site Restoration
- TI Waiver
- Installation of New Ground Water Monitoring Wells
- Long-Term Ground Water Monitoring
- Institutional Controls
- Annual Inspection/Review
- Five-Year Review

Alternative G-5 – Technical Impracticability (TI) Waiver (for Southern and Northern Areas)

Estimated Capital Cost: $698,000
Estimated Present Worth O&M Cost: $871,860
Estimated Total Present Worth Cost: $1,569,860

Implementation of this alternative would require a TI Waiver of ground water cleanup levels, specified in this Proposed Plan, within the TI Zone. The TI Zones consist of the delineated source areas and the downgradient areas where dissolved constituent concentrations exceed ground water cleanup levels and ARARs. The TI Zone will be established in the Southern and Northern Areas for both the Shallow and Intermediate Zones. The 2011 draft TI Demonstration Report presents the justification that a TI Waiver is necessary. New monitoring wells will be installed and at least two years of quarterly monitoring will be conducted in the Shallow Zone and Intermediate Zone to confirm the proposed the TI Zone boundary. The final TI Zone boundary will be documented in an Explanation of Significant Differences (ESD) document. After completion of two years of quarterly monitoring, the data will be evaluated to determine the nature and extent of plume and plume trends and verify natural attenuation is occurring to control the plume migration. Adjustments to the monitoring network will be made as necessary and the appropriate frequency of sampling will be determined. At the least, annual monitoring of the Shallow Zone and the Intermediate Zone will continue for at least five years after the completion of the two years of quarterly monitoring. If the sample results from the annual monitoring indicate a stable or decreasing plume vertically and horizontally the frequency of the sampling can be reduced to once in five years to coincide with the Five-Year Review cycle. Ground water monitoring results will be evaluated periodically and, based on the results, interim monitoring may be needed if any anomalies are identified. If anomalies are found, further evaluation will be performed to determine if other active contingency measures need to be taken. If DNAPL is present, it will continue to be removed in the impacted monitoring wells.

As previously discussed, because it has been determined that significant DNAPL recovery is technically impracticable, and because natural processes appear to adequately control dissolved phase COC migration, the operation of the existing ground water pumping/DNAPL recovery system would be discontinued under this alternative. All piping and the treatment plant would be permanently removed from service and would be decommissioned and dismantled.

This alternative would require that ICs be established to prohibit ground water use within the TI Zones in perpetuity. ICs, such as deed restrictions and restrictive covenants need to be established. The AOC between the EPA and the property owners that is already in place needs to be amended to include the current property owners. This alternative would include annual evaluations of the Site and the HGCSD well registration records to ensure that land and ground

water use at and in the vicinity of the Site does not change and to verify the continued absence of complete exposure pathways for Site ground water. This alternative will also include Five-Year Reviews.

The primary components of Alternative G-5 include:

- Decommissioning and Dismantling of Existing Ground Water Treatment System
- TI Waiver
- Installation of New Ground Water Monitoring Wells
- Short-Term Ground Water Monitoring (quarterly monitoring for at least 2 years)
- Long-Term Ground Water Monitoring (at least annual for at least five years and once in five years after that)
- Institutional Controls
- Five-Year Review

Alternative G–6: In-Situ Chemical Oxidation (ISCO) (for Northern Area only)

For Shallow Zone Only	For Shallow Zone, Intermediate Aquitard, and Intermediate Zone
Estimated Capital Cost: $4,725,275 Estimated Present Worth O&M Cost: $1,579,598 Estimated Total Present Worth Cost: $6,304,873	Estimated Capital Cost: $15,462,579 Estimated Present Worth O&M Cost: $1,579,598 Estimated Total Present Worth Cost: $17,042,177

This alternative addresses ground water in the Northern Area for 1) the Shallow Zone only and 2) all the Zones - the Shallow Zone, Intermediate Aquitard, and Intermediate Zones. It does not include any remediation in the Southern Area. Under this alternative, soils exhibiting the presence of potential source materials (i.e., DNAPL) would be treated using ISCO. In general, ISCO is a technology designed to destroy and/or immobilize organic chemicals in ground water. For coal tar/creosote-related constituents, ISCO has been specifically developed as a remedy to immobilize free phase DNAPL source materials through development of a weathered outer skin, often referred to as In-Situ bio-Geochemical Stabilization (ISGS). The ISGS process option results in a reduced mass flux of dissolved phase constituents through a combination of reduced aquifer permeability, reduced mass transfer of constituents into ground water (as a result of the "skin" effects), and temporary accelerated biodegradation of constituents in ground water as a result of the increased dissolved oxygen concentration following injection. No significant reduction in DNAPL mass is anticipated as a result of the ISGS type injection.

Alternatively, ISCO can be employed as a direct oxidation approach aimed at destruction of organic constituents. Compared to the ISGS option discussed above, effective direct oxidation requires more aggressive oxidants delivered at higher dosages. Direct oxidation also typically requires dissolution of separate phase DNAPL into ground water to be effective. These requirements result in a remedy that is difficult to implement as shown by numerous pilot studies. More aggressive oxidants suffer from short half-lives which make effective distribution through the aquifer problematic. Such a remedy may also typically require the addition of surfactants or co-solvents to dissolve separate phase DNAPL into the aquifer to make them available for oxidation. This is difficult to accomplish in low permeable soils and also can result in significant degradation of ground water quality if adequate controls cannot be assured. Due to these difficulties, the ISGS approach is the preferred approach instead of the direct oxidation approach and will be used in this evaluation.

In general the ISCO process relies on the delivery of chemical oxidants to affected media via injection wells, Geoprobe® injections, soil mixing, or similar methods. Although lateral distribution is problematic in tight formations using any of the preceding technologies, it has been assumed that Geoprobe® injection will be suitable for the South Cavalcade Site. The Geoprobe® injection spacing is dependent on the permeability and dispersion characteristics of the target zone.

Based upon the estimated source extent in the Shallow Zone only, approximately 56,360 cubic yards of soil would require treatment. In all the Zones approximately 127,231 cubic yards of soil would require treatment.

The operation of the existing ground water pumping/DNAPL recovery system would be discontinued under this alternative. All piping and the treatment plant would be permanently removed from service and would be decommissioned and dismantled. This alternative would also include post-treatment monitoring of ground water, the Site, and HGCSD well registration records, consistent with the MNA remedies proposed above under Alternatives G-2 and G-3.

ISGS will treat the soils containing the free phase DNAPL but will not address the dissolved contaminant plumes. Hence, implementation of this alternative would require a TI Waiver of ground water remedial goals, specified in this Proposed Plan, within the TI Zone. This alternative would require the use of ICs to ensure restrictions are place to prevent digging, excavation etc. To substantiate the ICs' prohibition on ground water use, verification that ground water is not being used will be made in conjunction with the long-term ground water monitoring program. ICs, such as deed restrictions and restrictive covenants need to be established. The AOC between the EPA and the property owners that is already in place needs to be amended to include the current property owners.

On-going long-term monitoring will be required to monitor the Shallow Zone and the Intermediate Zone. This alternative would include annual evaluations of the Site and the HGCSD well registration records to ensure that land and ground water use at and in the vicinity of the Site does not change and to verify the continued absence of complete exposure pathways for Site ground water. This alternative will also include Five-Year Reviews.

The primary components of Alternative G-6 include:

- In-Situ Chemical Oxidation
- Site Restoration
- Decommissioning and Dismantling of Existing Ground Water Treatment System
- TI Waiver
- Installation of New Ground Water Monitoring Wells
- Long-Term Ground Water Monitoring
- Institutional Controls
- Five-Year Review

Alternative G-7: In-Situ Solidification/Stabilization (ISSS) (for Northern Area only)

For Shallow Zone Only	For Shallow Zone, Intermediate Aquitard, and Intermediate Zones
Estimated Capital Cost: $5,874,050 Estimated Present Worth O&M Cost: $1,579,598 Estimated Total Present Worth Cost: $7,453,648	Estimated Capital Cost: $15,143,314 Estimated Present Worth O&M Cost: $1,579,598 Estimated Total Present Worth Cost: $16,722,913

This alternative addresses ground water in the Northern Area for 1) the Shallow Zone only and 2) all the Zones - the Shallow Zone, Intermediate Aquitard, and Intermediate Zones. It does not include any remediation in the Southern Area. Under this alternative, soils exhibiting the presence of potential source materials (i.e., DNAPL) would be treated via In-Situ Solidification/Stabilization (ISSS). Implementation of the ISSS remedy would limit the leaching of constituents from potential source materials into ground water and would reduce the permeability of the soil matrix to limit contact between ground water and impacted soils.

The ISSS process involves the mechanical mixing of reagents into the soils using equipment such as a backhoe, excavator, rotary mixer, or large diameter auger. The primary ISSS reagent(s) and application rate would be

determined during a bench scale treatability study, which would be conducted during the remedial design. Based upon the estimated source extent in the Shallow Zone only, approximately 56,360 cubic yards of soil would require treatment. In all the Zones approximately 127,230 cubic yards of soil would require treatment. Once completed, the Northern Area would be regarded and sloped to promote positive drainage.

The operation of the existing ground water pumping/DNAPL recovery system would be discontinued under this alternative. The treatment plant and all piping would be permanently removed from service and would be decommissioned and dismantled. This alternative would also include post-treatment monitoring of ground water, the Site, and HGCSD well registration records, as with other Alternatives.

ISSS will treat the soils containing the source materials but will not address the dissolved contaminant plumes. Hence, implementation of this alternative would require a TI Waiver of ground water cleanup levels, specified in this Proposed Plan, within the TI Zone. This alternative would require the use of ICs to ensure restrictions are place to prevent digging, excavation etc. ICs, such as deed restrictions and restrictive covenants need to be established. The AOC between the EPA and the property owners that is already in place needs to be amended to include the current property owners.

On-going long-term monitoring will be required to monitor the Shallow Zone and the Intermediate Zone. This alternative would include annual evaluations of the Site and the HGCSD well registration records to ensure that land and ground water use at and in the vicinity of the Site does not change and to verify the continued absence of complete exposure pathways for Site ground water. This alternative will also include Five-Year Reviews.

The primary components of Alternative G-7 include:

- In-Situ Source Stabilization (shallow soil mixing)
- Management of swell materials generated during stabilization
- Site Restoration
- Decommissioning and Dismantling of Existing Ground Water Treatment System
- TI Waiver
- Installation of New Ground Water Monitoring Wells
- Long-Term Ground Water Monitoring
- Institutional Controls
- Five-Year Review

Evaluation of Remedial Alternatives

The EPA uses nine criteria to evaluate remedial alternatives for the cleanup of a release. These nine criteria are categorized into three groups: threshold, balancing, and modifying. The threshold criteria must be met in order for an alternative to be eligible for selection. The threshold criteria are overall protection of human health and the environment and compliance with ARARs. The balancing criteria are used to weigh major tradeoffs among alternatives. The five balancing criteria are long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness, implementability; and cost. The modifying criteria are state acceptance and community acceptance, which are evaluated once the Proposed Plan public comment period is complete.

Based on the information and the analysis presented in the 2011 FFS, 2012 draft FFSA, and 2011 draft TI Demonstration Report, EPA has identified the following preferred remedial alternative:

Ground Water

Alternative G-5 – Technical Impracticability (TI) Waiver

The EPA may modify its position regarding site remediation based on its assessment of community acceptance and state acceptance, the final two criteria, which will be described in the ROD Amendment and in the Responsiveness Summary after comments are received.

Comparative Analysis of Remedial Technologies Relative to Ground Water, and the Original Remedy (1988 ROD)

The following section provides a comparative analysis of the remedial technologies for soils and ground water, relative to the nine evaluation criteria and the remedy selected in the 1988 ROD. In 1988, EPA selected as the Site remedy the extraction and treatment of contaminated ground water with carbon adsorption.

7.2.1 Overall Protection of Human Health and the Environment

The different technologies, or technology combinations, considered in the 2011 FFS and 2012 draft FFSA for ground water provide slightly differing degrees of protection for human health and the environment. Basic comparative analyses for the technologies, or technology combinations, for ground water are presented below.

All alternatives except Alternative G-1, provide protection of human health and the environment. With the other remedial alternatives, protection is provided through the use of long-term monitoring to confirm the ground water exposure pathway remains incomplete, and through the use of ICs to restrict ground water use in the affected areas during active remediation. Currently, although the aquifer is considered a potential drinking water source, there are no identified users.

In all alternatives, contaminants in the dissolved phase in the ground water would be allowed to attenuate naturally. Alternatives G-3, G-4, G-6, and G-7 all involve various forms of source area control or reduction. Under Alternative G-2 and G-5 no action would be performed in the source areas, thus allowing the DNAPL/ residual DNAPL to source the dissolved plume, although long-term monitoring and ICs would control exposure while the plume naturally attenuates over time.

Calculations in the 2011 FFS show that it will take more than 170 years to deplete naphthalene from the source zone. Benzene, which is more soluble, is anticipated to be depleted in a shorter time frame than naphthalene. The remediation time frame is anticipated to be the shortest for G-4. A monitoring plan will be developed for those alternatives requiring short term and long-term monitoring.

Original Remedy (1988)
The original remedy was selected to be protective of human health and the environment. The selected remedy was expected to reduce ground water contamination to an acceptable 1×10^{-4} risk to human health, prevent any non-carcinogenic hazards, and prevent continued leaching of creosote compounds from soils to ground water. Although the ground water system did retrieve and treat contaminated ground water and DNAPL, the system could not effectively treat the entire DNAPL volume that is present.

7.2.2 Compliance with ARARs

All the alternatives will not meet the ARARs. The alternatives G-1, G-2, and G-5 will not meet the ARARs for the MCLs for the COCs nor the State standard for naphthalene across the dissolved phase ground water plume associated with the Site. As of December 2011 a total of approximately 4000 gallons of DNAPL have been recovered. The

DNAPL recovery system was only able to remove an estimated 1.7% of the estimated total DNAPL mass. The 2011 FFS show that it will take more than 170 years to deplete naphthalene from the source zone and hence the dissolved contaminant plumes will take a long time to meet the ARARs for the Site. In the alternatives G-3, G-4. G-6, and G-7 the dissolved phase ground water contamination is anticipated to exist even after treatment of source areas and hence these alternatives will also not meet the ARARs.

Original Remedy (1988)
The original remedy, as selected, was consistent with those laws applicable or relevant and appropriate to CERCLA activities.

7.2.3 Long-term Effectiveness and Permanence

Alternative G-1 does not provide long-term effectiveness and permanence. Natural attenuation process has been demonstrated for naphthalene and benzene and is a key contributor for maintaining overall plume stability in alternatives G-2, G-3, and G-5. Although attenuation of the COCs will continue to decrease concentrations for parts of the dissolved contaminant plumes, the complete restoration of the ground water is not anticipated for these alternatives. Although alternatives G-3, G-4, G-6, and G-7 include provisions to minimize plume expansion from the DNAPL source areas, complete restoration of the ground water is not anticipated for these alternatives.

Original Remedy (1988)
The original remedy, as selected, met the criteria for long-term effectiveness and permanence through the reduction of contaminant concentrations throughout treatment. The ground water pump and treat remedy reduced contaminant concentrations, but with very limited efficiency.

7.2.4 Reduction of Toxicity, Mobility, and Volume (TMV) of Contaminants through Treatment

Alternatives G-1, G-2, and G-5 do not include active treatment to reduce the TMV of source material or the contaminated ground water. The COCs in the plume would be left to attenuate naturally over time. The existing Site geology and hydrogeology conditions have limited the migration of the dissolved contaminant plumes to a relatively short distance of the source areas. Calculations in the 2011 FFS show that it will take more than 170 years to deplete naphthalene from the source zone without treatment. Benzene, which is more soluble, is anticipated to be depleted in a shorter time frame than naphthalene. Alternative G-3 includes DNAPL removal and treatment to reduce TMV of DNAPL. Alternatives G-4, G-6, and G-7 incorporate active treatment in-situ to reduce the mobility of the DNAPL source material. In all these alternatives the TMV of contaminants in the dissolved contaminant plume would be reduced by a natural attenuation process.

Original Remedy (1988)
The original selected remedy was for treatment to completely remediate the ground water. The ROD did not differentiate between addressing the source and the dissolved phase plume.

7.2.5 Short-term Effectiveness

For G-1, G-2, and G-5 the short term risks to workers, the community, and the environment are expected to be minimal since there are no current ground water users. Alternative G-3 will have some risk to workers during remedial action due to exposure encountered during continued source removal. Alternatives, G-4, G-6, and G-7 will also have some risk to workers during remedial action due to exposure during treatment of contaminated soils. Construction of the Hardy Toll Road adjacent to the west side of the Site and along Collingsworth adjacent to the south side of the Site may increase the likelihood of exposure in the short term for construction workers with all these alternatives. Alternatives G-1, G-2, and G-5 will have higher short-term protectiveness based on community and worker protection during the remedial action.

Original Remedy (1988)

The original remedy involved a small short-term risk since onsite workers could be exposed to contaminants in the extracted ground water.

7.2.6 Implementability

There are no technical issues with the implementation of Alternatives G-1, G-2, and G-5. Alternatives G-3, G-4, G-6, and G-7 all involve technologies, services, and materials that are readily available. Alternatives G-3 and G-4 will be difficult to implement in the Southern Area due to on-going operations and truck traffic from the existing transportation companies located in this area and existing surface improvements including roads, railroads, and utilities. ICs are required to maintain the permanence and effectiveness of Alternatives G-2 through G-7 both onsite and offsite. The specific ICs such as deed restrictions and restrictive covenants to be used and the specific details for these will need to be developed, including surveys for the affected areas of land.

Original Remedy (1988)
The ground water pump and treat system was considered implementable.

7.2.7 Cost

Alternative G-1, the no action alternative will have no associated cost.

Alternative G-2 is estimated to be **$1,177,341 (net present value)** based on $167,188 total capital cost and $1,010,154 total O&M cost. The capital cost includes installation of seven additional wells, demolition of existing treatment system, and establishing ICs. Total O&M cost is for the 30 year MNA program implementation, annual inspection, and Five-Year review.

Alternative G-3 is estimated to be **$5,392,516 (net present value)** based on $154,938 total capital cost and $5,237,578 total O&M cost. The capital cost includes installation of seven additional wells, repair of the treatment system, and establishing ICs. Total O&M cost is for implementing a MNA program with continued source removal, demolition of existing treatment system, installation of new treatment system, and ICs. It includes annual inspection and Five-Year review. These costs do not account for establishing and monitoring a TI Waiver Zone.

Alternative G-4 is estimated to be **$18,137,623 (net present value)** based on $16,558,025 total capital cost and $1,579,598 total O&M cost. The capital cost includes replacing monitoring wells, design and implementing ISSS, and establishing ICs. The total O&M costs includes ground water monitoring, annual inspection, and Five-Year review costs. These costs do not account for establishing and monitoring a TI Waiver Zone.

Alternative G-5 is estimated to be **$1,569,860 (net present value)** based on $698,000 total capital cost and $871,860 total O&M cost. The capital cost includes evaluation of the Northern Area, establishing a TI Waiver Zone, installation and abandonment of monitoring wells, demolition of existing treatment system, and establishing ICs. Total O&M cost is for the 30 year monitoring program implementation and short term and long-term ground water monitoring program to monitor the TI Zone, annual inspection, and Five-Year review.

Alternative G-6 is estimated to be **$6,279,873 (net present value)** based on $4,700,275 total capital cost and $1,579,598 total O&M cost for the Shallow Zone. The cost for the Shallow Zone, Intermediate Aquitard, and Intermediate Zone is estimated to be $17,042,177 (net present value) based on $15,462,579 total capital cost and $1,579,598 total O&M cost. These costs do not include remedy implementation for the Southern Area. The capital costs include ISCO pilot study and implementation, demolition of existing treatment system, and establishing ICs. The total O&M costs includes ground water monitoring, annual inspection, and Five-Year review costs. These costs do not account for establishing and monitoring a TI Waiver Zone.

Alternative G-7 is estimated to be **$7,428,648 (net present value)** based on $5,849,050 total capital cost and $1,579,598 total O&M cost for the Shallow Zone. The cost for the Shallow Zone, Intermediate Aquitard, and Intermediate Zone is estimated to be $7,453,648 (net present value) based on $5,874,050 total capital cost and $1,579,598 total O&M cost. These costs do not include remedy implementation for the Southern Area. The capital costs include ISSS bench scale testing and implementation, demolition of existing treatment system, and establishing ICs. The total O&M costs include ground water monitoring, annual inspection, and Five-Year review costs. These costs do not account for establishing and monitoring a TI Waiver Zone.

The costs associated with Alternatives G-2 and G-5 are significantly lower than Alternatives G-3, G-4, G-6, and G-7. The high costs of these alternatives are due to the active removal/treatment of the source area. Alternative G-1 is the least expensive alternative.

The cost estimates presented above have been developed strictly for comparing seven remedial alternatives. The final costs and the resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, the implementation schedule, final engineering design, and other variables.

Original Remedy (1988)
In 1988, the estimated costs for the ground water treatment remedy was $8,300,000 (net present value) and $3,800,000 capital costs and $482,222 annual O&M .

7.2.8 State Acceptance

The EPA has developed the proposed action in consultation with TCEQ and will request concurrence by the State of Texas upon completion of the public comment period.

7.2.9 Community Acceptance

Community acceptance of the Preferred Remedy Alternative will be evaluated after the public comment period ends and will be described in the ROD Amendment for the Site.

Summary of the Preferred Remedial Alternative

Ground Water

The preferred remedial alternative for addressing the contaminants in ground water and meeting the primary remedial objectives is Alternative G-5: Technical Impracticability (TI) Waiver.

- Contain the two ground water contaminant plumes in the Northern Area and Southern Area, in both Shallow and Intermediate Zones, through natural processes, as restoration goals will not be achievable throughout the dissolved contaminant plumes.

- Waive the ground water ARARs for selected chemicals within a designated area, referred to as the Technical Impracticability (TI) Zone; The boundaries of the proposed TI Zone include both onsite and offsite areas and apply to both of the impacted aquifers in the Southern and Northern Areas of the Site. Within the boundaries of the TI Zone, cleanup levels will be waived for total PAHs including cPAHs, benzene, ethylbenzene, toluene, and xylene, arsenic, chromium, copper, lead, and zinc. The cPAHs are benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene).

- Prevent exposure to contaminated ground water above acceptable risk levels by implementing ICs to restrict access to, or use of, contaminated water. ICs (i.e. deed restrictions, or restrictive covenants) will be put in place to provide notice to property owners and prospective purchasers that contaminated water from the

Shallow and Intermediate Zones should not be used for drinking water or non-drinking uses. The AOC between the EPA and the property owners that is already in place needs to be amended to include the current property owners.

- New monitoring wells will be installed and at least two years of quarterly monitoring will be conducted in the Shallow Zone and Intermediate Zone to confirm the proposed the TI Zone boundary. The final TI Zone boundary will be documented in an ESD document. After completion of two years of quarterly monitoring, the data will be evaluated to determine the nature and extent of plume and plume trends. Adjustments to the monitoring network will be made as necessary and the appropriate frequency of sampling will be determined. Long-term monitoring will be conducted to ensure that the plume is not expanding and to very areas of increasing or decreasing contaminant concentrations within the TI Zone. At the least, annual monitoring of the Shallow Zone and the Intermediate Zone for the two Areas will continue for at least five years after the completion of the two years of quarterly monitoring. If the sample results from the annual monitoring indicate a stable or decreasing plume vertically and horizontally the frequency of the sampling can be reduced to once in five years to coincide with the Five-Year Review cycle. Ground water monitoring results will be evaluated periodically and based on the results interim monitoring may be needed if any anomalies are identified. If anomalies are found, further evaluation will be performed to determine if other active contingency measures should be taken. If DNAPL is present, it will continue to be removed in the impacted monitoring wells.

- The ground water treatment system and piping, however, will not be used with this remedy, and will be decommissioned and dismantled

Glossary

Administrative Record – The body of documents available to the public associated with characterization and remedy selection at a site.

Applicable or Relevant and Appropriate Requirements (ARARs) – The Federal and State environmental laws that a selected remedy will meet. These requirements may vary among sites and alternatives.

Human Health Baseline Risk Assessment – An evaluation of the potential threat to human health in the absence of any remedial action.

Carcinogen – Capable of causing the cells of an organism to react in a manner to produce cancer.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) - was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.

Contaminant Plume – A zone of contamination with measurable horizontal and vertical dimensions that is suspended in and moves with ground water.

Contaminants of Concern (COCs) – COCs or chemicals of concern are contaminants if exposed to affect human health and hence are considered in the evaluation of the site remedial alternatives

Dense Non-aqueous Phase Liquids (DNAPL) – A DNAPL is an organic substance that is relatively insoluble in water and denser than water. DNAPLs tend to sink vertically through sand and gravel aquifers to the underlying layer.

Excess Lifetime Cancer Risk - Cancer posed by a contaminated site in excess of the lifetime probability of developing cancer from other causes.

Focused Feasibility Study (FFS) – Identifies and evaluates the appropriate technical approaches and treatment technologies to address contamination at a site. The 2011 Focused Feasibility Study for the South Cavalcade Site evaluated the proposed changes to the ground water remedy selected in the 1988 ROD. The 2012 FFS addendum considered additional alternatives for the Northern Area.

Ground Water – Underground water that fills pores in soils or openings in rocks to the point of saturation. Ground water is often used as a source of drinking water via municipal or domestic wells.

Ground Water Monitoring – Ongoing collection of ground water information about the environment that helps gauge the effectiveness of a cleanup action.

Hazard Index (HI) – It is the sum of more than one hazard quotient for multiple substances and/or multiple exposure pathways. The acceptable risk value is 1. Anything below this value is protective of human health and the environment.

Human Health Risk Assessment (HHRA) – A study that determines and evaluates risks that the site contamination poses to human health.

In-Situ bio-Geochemical Stabilization (ISGS) – It is a ISCO treatment technology used for coal tar/creosote-related constituents to immobilize free phase DNAPL source materials through development of a weathered outer skin.

In-Situ Chemical Oxidation (ISCO) – It is a treatment technology used for soil and groundwater to reduce concentrations of contaminants. In the direct oxidation approach, chemical oxidizers are directly injected into the soil/groundwater to destroy chemical contaminants in place.

In-Situ Solidification/Stabilization (ISSS) – It is a treatment technology used to stabilize or solidify soils in place. This technology locks the contaminants in low permeability and high strength monolithic blocks.

Institutional Control – An action or a legal instrument that helps minimize the potential for human exposure to contamination by ensuring appropriate land use.

Microgram per Liter (µg/L) - A unit of measurement equivalent to one microgram of contaminant per liter of water or approximately one part per billion.

Monitored Natural Attenuation (MNA) – refers to a ground water remedy that relies on natural processes to cleanup or attenuate pollution and actively monitors these processes.

National Oil and Hazardous Substance Pollution Contingency Plan (NCP) – Regulations governing cleanups under EPA's Superfund program.

Natural Attenuation – The processes in soil and ground water environments that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentrations of contaminants in those media. These in-situ processes include biodegradation, dispersion, dilution, adsorption, volatilization, and chemical or biological stabilization or destruction of contaminants.

Polynuclear Aromatic Hydrocarbons (PAHs) – Many of these compounds are highly carcinogenic at relatively low levels.

Present Worth Cost – A method of evaluation of expenditures that occur over different time periods. By discounting all costs to a common base year (using a 5% discount rate), the costs for different remedial action alternatives can be compared on the basis of a single figure for each alternative. When calculating present worth cost for Superfund sites, total operations & maintenance costs are to be included.

Proposed Alternative – Selected remedial alternative that meets NCP evaluation criteria and is supported by regulatory agencies.

Remedial Action – Action(s) taken to correct or remediate contamination.

Remedial Action Objectives (RAOs) – Remediation objectives for protection of human health and the environment.

Record of Decision (ROD) – A formal document that is a consolidated source of information about a Superfund site, the remedy selection process, and the selected remedy.

Remedial Investigation (RI) – A study conducted to identify the types, amounts, and locations of contamination at a site.

Technical Impracticability (TI) – Various factors can inhibit ground water restoration and attaining clean-up levels can be technically impracticable with available technologies.

Technical Impracticability Zone – TI Zone or TI Waiver Zone is a zone that is established around the contaminant plume, within which the ground water clean-up levels will be waived

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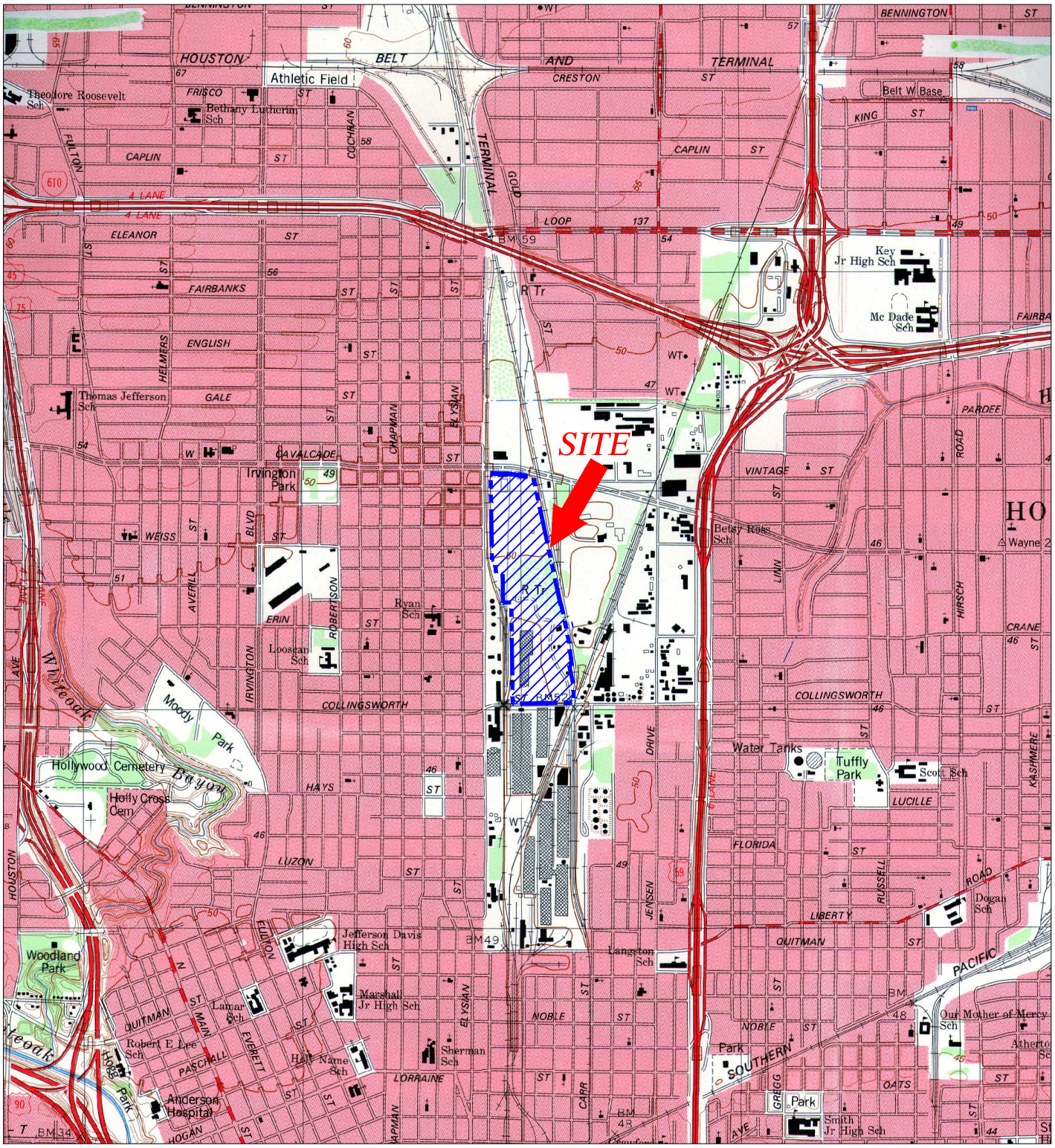
You can find more information about the Region 6 Superfund program on EPA's Region 6 website
http://www.epa.gov/earth1r6/6sf/6sf.htm



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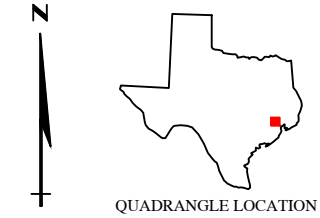

QUADRANGLE LOCATION

REFERENCE: USGS 7.5 MINUTE TOPOGRAPHIC QUADRANGLE OF SETTEGAST, TEXAS – 1982

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

BEAZER EAST, INC
PITTSBURGH, PENNSYLVANIA

DRWN: SCC	DATE: 07/11/13	KEY ENVIRONMENTAL INCORPORATED
CHKD: JSZ	DATE: 07/11/13	
APPD:	DATE:	
SCALE:	1" = 2000'	

SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS

SITE LOCATION MAP

PROJECT NO: 13-665
FIGURE 1

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N

CAVALCADE ST.

ONSITE BUILDING

NORTHERN AREA

NORTHEAST AREA
(EXCAVATION OF IMPACTED SOILS, BACKFILLED WITH CLEAN IMPORTED FILL, AND SEEDED)

ONSITE BUILDING

ONSITE BUILDING

ONSITE BUILDING

SOUTHERN AREA

ELYSIAN ST.
EVELYN ST.
FRAWLEY ST.
ADMUNDSON ST.
WEISS ST.
MALVERN ST.
EYGPT ST.
FINCH ST.
ERIN ST.
SHELBYST.
ALBER ST.
SUNTON ST.
COLLINGSWORTH ST.
MAURY ST.
SCHAEFER ST.
CARR ST.
HARDY ST.

LEGEND:

- SITE BOUNDARY
- RAILROAD
- STREETS
- AREAS COVERED WITH ASPHALT OR CONCRETE
- CONCRETE CAP CONSTRUCTED BY BEAZER

0 300 600 FEET

BEAZER EAST, INC.
PITTSBURGH, PENNSYLVANIA

DRWN:	SCC	DATE: 06/17/13	KEY ENVIRONMENTAL INCORPORATED
CHKD:	JSZ	DATE: 06/17/13	
APPD:		DATE:	
SCALE:	AS SHOWN		

SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS

SITE MAP

PROJECT NO: 13-665
FIGURE 2

REV #	DATE	DESCRIPTION	APPD
1			

REFERENCE:

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

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LEGEND

- SITE BOUNDARY
- PROPERTY BOUNDARIES
- PROPOSED HARDY TOLL ROAD EXTENSION RIGHT-OF-WAY
- AREAS COVERED WITH ASPHALT OR CONCRETE
- MW-12R — MONITORING WELL LOCATION
- DPN-L2 — DIRECT PUSH BORING PIEZOMETER LOCATION
- PZN-40 — PIEZOMETER LOCATION
- RWN-4 — RECOVERY WELL LOCATION
- AUGER BORING LOCATION (APPROX.)
- REMEDIAL INVESTIGATION SOIL BORING LOCATION
- 2012 DIRECT PUSH BORING (SHALLOW ZONE)
- 2012 DIRECT PUSH BORING (INTERMEDIATE ZONE)

LOCATION MAP

BEAZER EAST, INC.
PITTSBURGH, PENNSYLVANIA

DRWN: SCC	DATE: 07/11/13
CHKD: JMV	DATE: 07/11/13
APPD:	DATE:
SCALE: AS SHOWN	

KEY ENVIRONMENTAL INCORPORATED

SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS

CROSS SECTION LOCATION MAP

PROJECT NO: 12-517
FIGURE 3

REV #	DATE	DESCRIPTION	APPD
1			

REFERENCE: PROPOSED HARDY TOLL ROAD EXTENSION RIGHT-OF-WAY BASED ON HARDY CONNECTOR SCHEMATIC - FROM: US59/IH10 INTERCHANGE TO: HARDY TOLL ROAD/IH10 610 INTERCHANGE, DANNENBAUM ENGINEERING CORPORATION, 07/24/2009.

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

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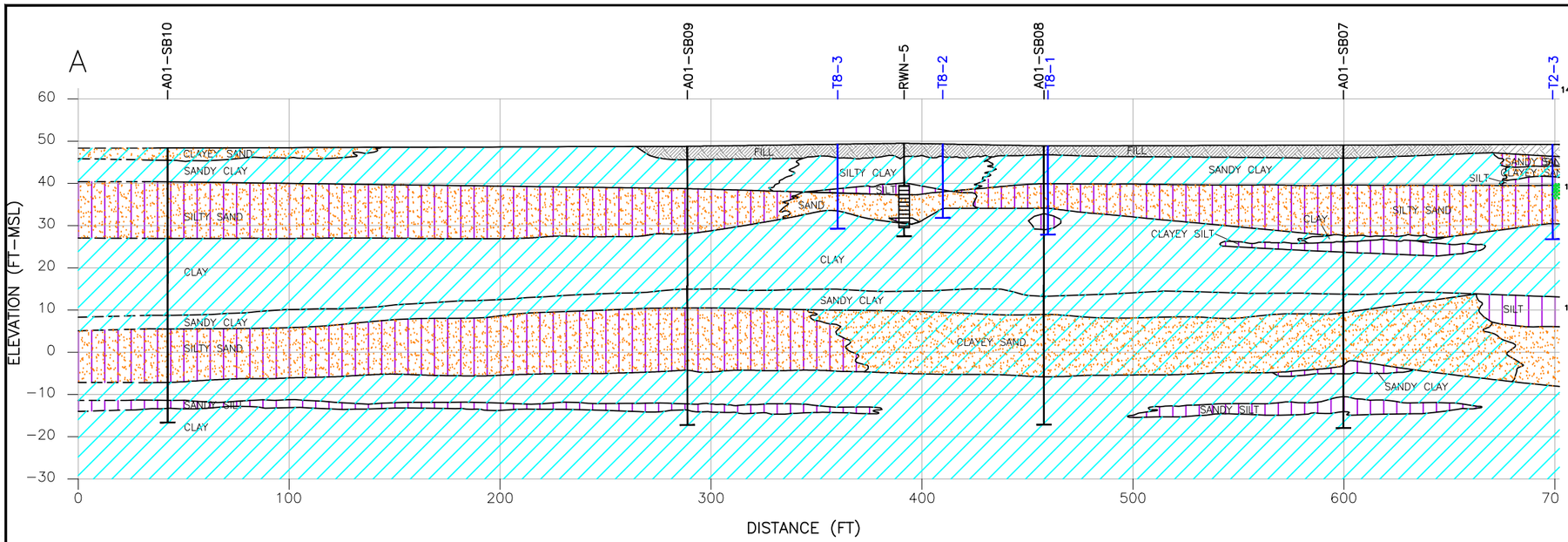

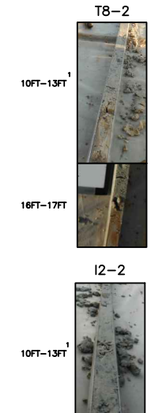

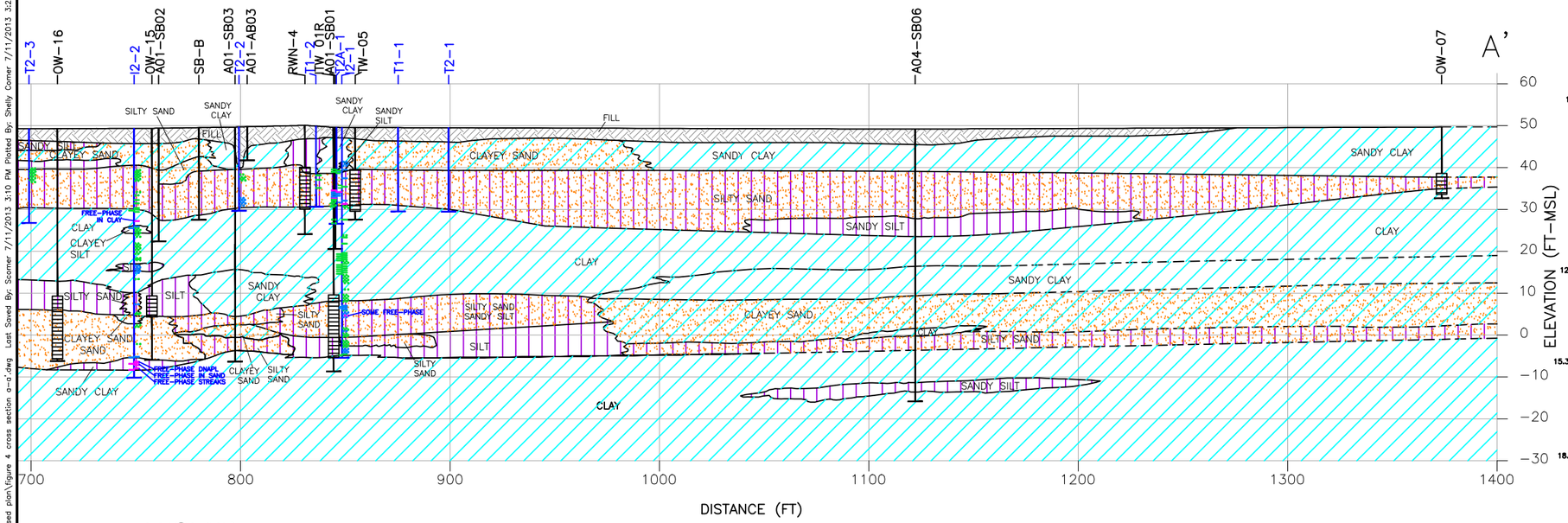

LEGEND

- FILL
- SAND
- SILT, CLAYEY SILT
- SILTY SAND, SANDY SILT
- CLAY, SANDY CLAY, SILTY CLAY
- CLAYEY SAND
- DISCONTINUOUS SPOTS OR PATCHES OVER INTERVAL INDICATED
- THIN LENSES OF MATERIAL AT DEPTHS INDICATED
- OILY RESIDUE, OIL SPOTS, SOLIDIFIED TAR, STAINING
- SHEEN
- FREE PHASE DNAPL

NOTE:
THE CROSS SECTIONS ARE AN IDEALIZED REPRESENTATION OF STRATIGRAPHY AND VISUAL OBSERVATIONS. REFER TO BORING LOGS FOR DETAILED DESCRIPTIONS OF OBSERVATIONS.

V: 0 30 60 FEET
H: 0 60 120 FEET

NOTE:
1. APPROXIMATE CORE INTERVAL DEPICTED.

BEAZER EAST, INC.
PITTSBURGH, PENNSYLVANIA

DRWN: SCC	DATE: 10/29/12	KEY ENVIRONMENTAL INCORPORATED	
CHKD: JMV	DATE: 10/29/12		
APPD: JSZ	DATE: 10/29/12		
SCALE:	AS SHOWN		

SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS

CROSS SECTION A-A' WITH PHOTOS

PROJECT NO: 12-517
FIGURE 4

REV #	DATE	DESCRIPTION	APPD
1			
2			
3			

REFERENCE:

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

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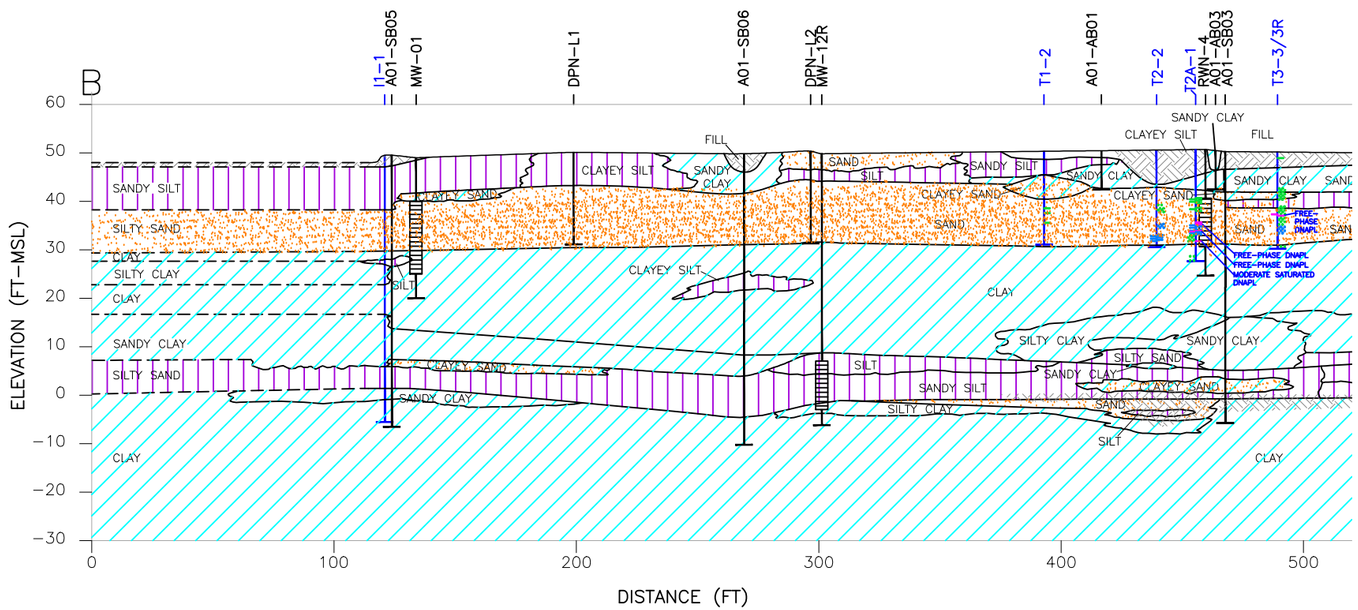

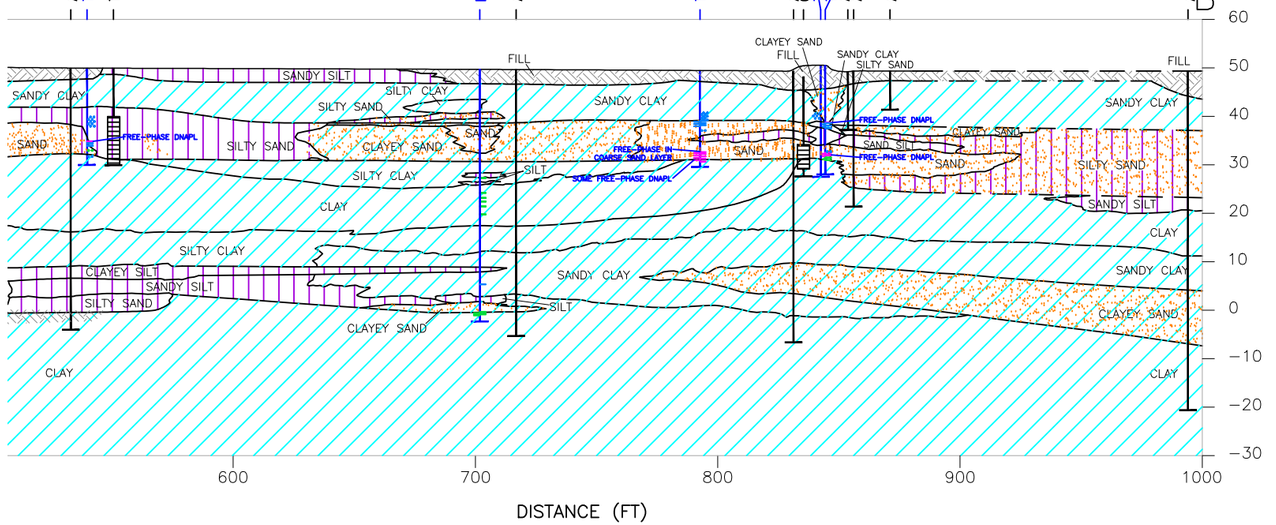

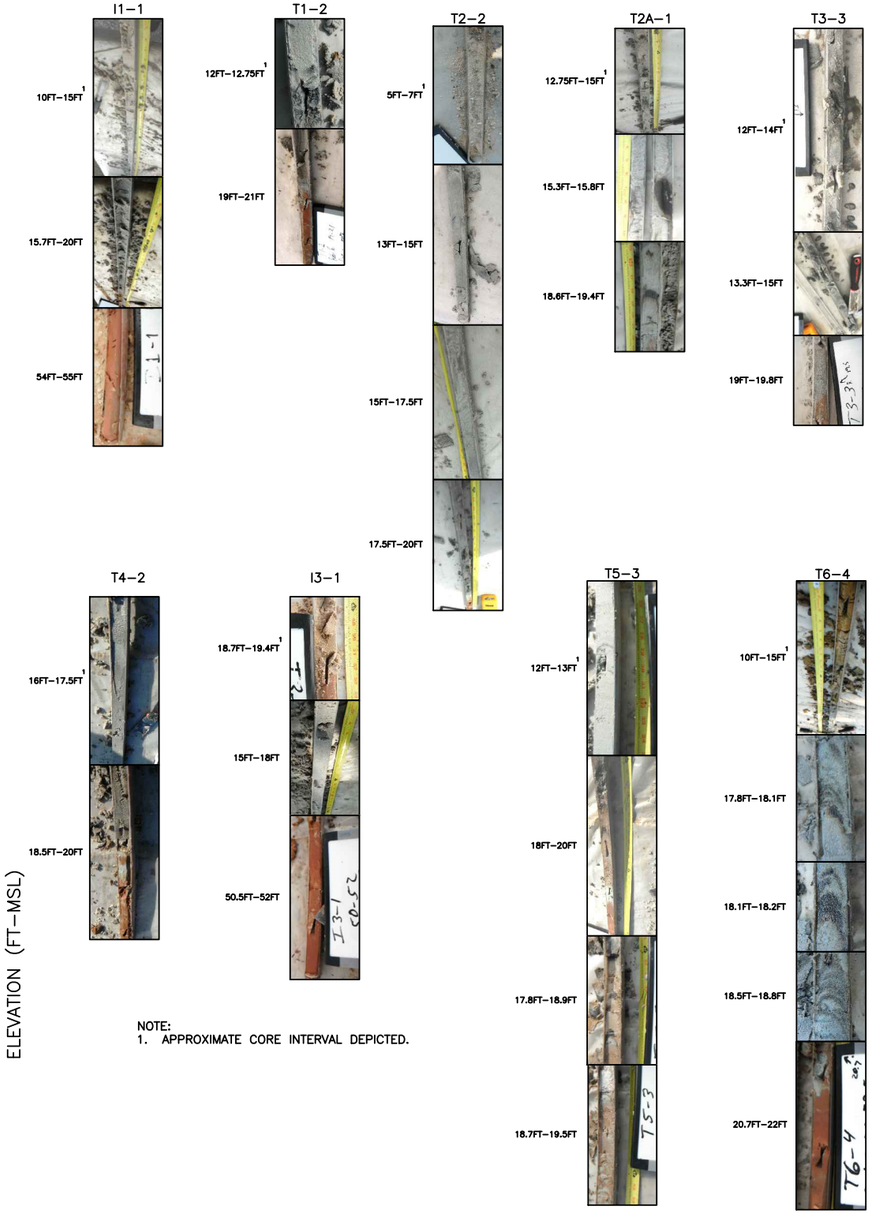

NOTE:
1. APPROXIMATE CORE INTERVAL DEPICTED.

LEGEND

- FILL
- SAND
- SILT, CLAYEY SILT, SANDY SILT
- SILTY SAND
- CLAY, SANDY CLAY, SILTY CLAY
- CLAYEY SAND
- DISCONTINUOUS SPOTS OR PATCHES OVER INTERVAL INDICATED
- THIN LENSES OF MATERIAL AT DEPTHS INDICATED
- OILY RESIDUE, OIL SPOTS, SOLIDIFIED TAR, STAINING
- SHEEN
- FREE PHASE DNAPL

NOTE:
THE CROSS SECTIONS ARE AN IDEALIZED REPRESENTATION OF STRATIGRAPHY AND VISUAL OBSERVATIONS. REFER TO BORING LOGS FOR DETAILED DESCRIPTIONS OF OBSERVATIONS.

V: 0 30 60 FEET
H: 0 60 120 FEET

REV #	DATE	DESCRIPTION	APPD
1			
2			
3			

REFERENCE:

ISSUE DATE:

KEY ENVIRONMENTAL, INC.
200 THIRD AVENUE
CARNEGIE, PA 15106

BEAZER EAST, INC.
PITTSBURGH, PENNSYLVANIA

DRWN: SCC	DATE: 07/11/13	KEY ENVIRONMENTAL INCORPORATED	
CHKD: JMV	DATE: 07/11/13		
APPD:	DATE:		
SCALE: AS SHOWN			

SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS

CROSS SECTION B–B' WITH PHOTOS

PROJECT NO: 12-517
FIGURE 5

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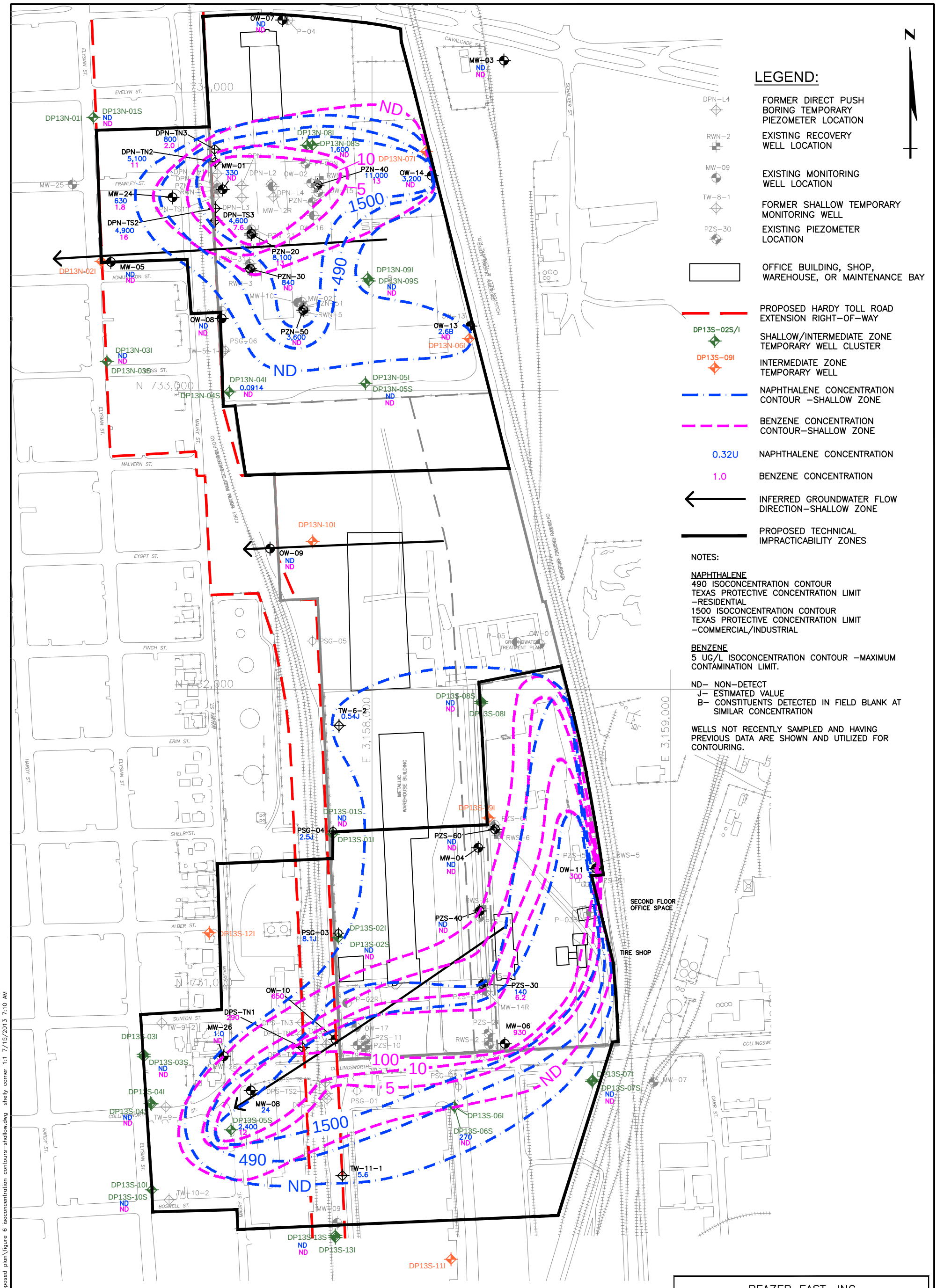
y:\south cavalcade\13-665\2013 draft report\proposed plan\figure 5 cross section b-b'.dwg Last Saved By: Scorner 7/11/2013 3:25 PM Plotted By: Shelly Corner 7/11/2013 3:26 PM Scale: 1:1



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CHKD: JSZ	DATE: 07/11/13		
APPD:	DATE:		
SCALE: AS SHOWN			

SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS

BENZENE AND NAPHTHALENE IN THE SHALLOW ZONE

PROJECT NO: 13–665

FIGURE 6

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CARNEGIE, PA 15106

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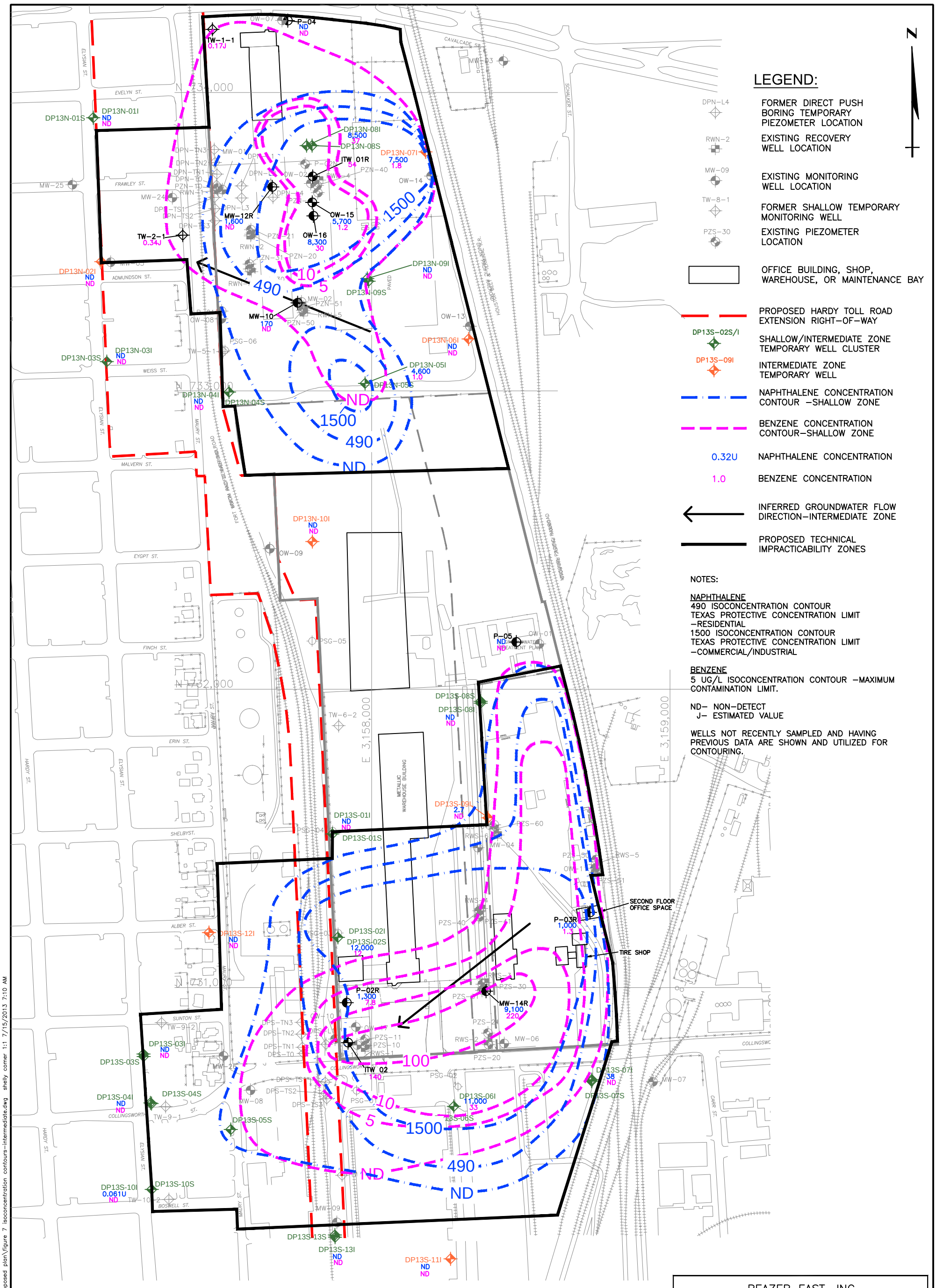
LEGEND:
DPN–L4 FORMER DIRECT PUSH BORING TEMPORARY PIEZOMETER LOCATION
RWN–2 EXISTING RECOVERY WELL LOCATION
MW–09 EXISTING MONITORING WELL LOCATION
TW–8–1 FORMER SHALLOW TEMPORARY MONITORING WELL
PZS–30 EXISTING PIEZOMETER LOCATION
OFFICE BUILDING, SHOP, WAREHOUSE, OR MAINTENANCE BAY
PROPOSED HARDY TOLL ROAD EXTENSION RIGHT–OF–WAY
DP13S–02S/I SHALLOW/INTERMEDIATE ZONE TEMPORARY WELL CLUSTER
DP13S–09I INTERMEDIATE ZONE TEMPORARY WELL
NAPHTHALENE CONCENTRATION CONTOUR –SHALLOW ZONE
BENZENE CONCENTRATION CONTOUR–SHALLOW ZONE
0.32U NAPHTHALENE CONCENTRATION
1.0 BENZENE CONCENTRATION
INFERRED GROUNDWATER FLOW DIRECTION–INTERMEDIATE ZONE
PROPOSED TECHNICAL IMPRACTICABILITY ZONES
NOTES:
NAPHTHALENE
490 ISOCONCENTRATION CONTOUR
TEXAS PROTECTIVE CONCENTRATION LIMIT –RESIDENTIAL
1500 ISOCONCENTRATION CONTOUR
TEXAS PROTECTIVE CONCENTRATION LIMIT –COMMERCIAL/INDUSTRIAL
BENZENE
5 UG/L ISOCONCENTRATION CONTOUR –MAXIMUM CONTAMINATION LIMIT.
ND– NON–DETECT
J– ESTIMATED VALUE
WELLS NOT RECENTLY SAMPLED AND HAVING PREVIOUS DATA ARE SHOWN AND UTILIZED FOR CONTOURING.
N
0 300 600 FEET
BEAZER EAST, INC.
PITTSBURGH, PENNSYLVANIA
DRWN: SCC DATE: 07/11/13
CHKD: JSZ DATE: 07/11/13
APPD: DATE:
SCALE: AS SHOWN
KEY ENVIRONMENTAL INCORPORATED
SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS
BENZENE AND NAPHTAHLENE IN THE INTERMEDIATE ZONE
PROJECT NO: 13–665
FIGURE 7
REV # DATE DESCRIPTION APPD
REFERENCE:
ISSUE DATE:
KEY ENVIRONMENTAL, INC. 200 THIRD AVENUE CARNEGIE, PA 15106
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LEGEND:

OFFICE BUILDING, SHOP, WAREHOUSE, OR MAINTENANCE BAY

PROPOSED HARDY TOLL ROAD EXTENSION RIGHT-OF-WAY

PROPOSED TECHNICAL IMPRACTICABILITY ZONES

ELYSIAN ST.
EVELYN ST.
FRAWLEY ST.
ADMUNDSON ST.
WEISS ST.
MALVERN ST.
EYGPT ST.
FINCH ST.
ERIN ST.
SHELBYST.
ALBER ST.
SUNTON ST.
BOSWELL ST.
COLLINGSWORTH ST.
CAVALCADE ST.
SCHALKER ST.
CARR ST.
HARDY ST.
MAURY ST.
PAVED
METALIC WAREHOUSE BUILDING
GROUNDWATER TREATMENT PLANT
SECOND FLOOR OFFICE SPACE
TIRE SHOP

0 300 600 FEET

BEAZER EAST, INC.
PITTSBURGH, PENNSYLVANIA

DRWN:	SCC	DATE: 07/12/13	KEY ENVIRONMENTAL INCORPORATED
CHKD:	JSZ	DATE: 07/12/13	
APPD:		DATE:	
SCALE:	AS SHOWN		

SOUTH CAVALCADE SUPERFUND SITE
HOUSTON, TEXAS

PROPOSED TI ZONE

PROJECT NO: 13-665
FIGURE 8

REV #	DATE	DESCRIPTION	APPD
1			
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REFERENCE:

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CARNEGIE, PA 15106

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